



U.S. Department of the Interior
U.S. Geological Survey

MINERALS YEARBOOK

Area Reports: International 1998

Africa and the Middle East

Volume III

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Volume III

U.S. DEPARTMENT OF THE INTERIOR
GALE NORTON, Secretary

U.S. GEOLOGICAL SURVEY
CHARLES G. GROAT, Director

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Foreword

This edition of the U.S. Geological Survey (USGS) Minerals Yearbook discusses the performance of the worldwide minerals and materials industries during 1998 and provides background information to assist in interpreting that performance. Content of the individual Minerals Yearbook volumes follows:

- Volume I, Metals and Minerals, contains chapters about virtually all metallic and industrial mineral commodities important to the U.S. economy. Chapters on survey methods, summary statistics for domestic nonfuel minerals, and trends in mining and quarrying in the metals and industrial minerals industries in the United States are also included.
- Volume II, Area Reports: Domestic, contains a chapter on the mineral industry of each of the 50 States and Puerto Rico and the Administered Islands. This volume also has chapters on survey methods and summary statistics for domestic nonfuel minerals.
- Volume III, Area Reports: International, is published as four separate reports. These regional reports contain the latest available minerals data on more than 190 foreign countries and discuss the importance of minerals to the economies of these nations and the United States. Each report begins with an overview of the region's mineral industries during the year. It continues with individual country chapters that examine the mining, refining, processing, and use of minerals in each country of the region and how each country's mineral industry relates to U.S. industry. Most chapters include production tables and industry structure tables, information about Government policies and programs that affect the country's minerals industry, and an outlook section.

The USGS continually strives to improve the value of its publications to users. Constructive comments and suggestions by readers of the Minerals Yearbook are welcomed.

Charles G. Groat, Director

Contacts

Information about the U.S. Geological Survey, its programs, staff, and products may be accessed on the World Wide Web at URL <http://www.usgs.gov/> or by contacting the Earth Science Information Center at 1-888-ASK-MAPS. For specific information about this publication, contact the Chief, International Minerals Section, Minerals Information Team, at (703) 648-7732 or the Chief, Publication Services Section, Minerals Information Team, at (703) 648-4750. Additional minerals information may be accessed on the World Wide Web at <http://minerals.usgs.gov/minerals/>.

Acknowledgments

The Country Specialists in the Minerals Information Team, U.S. Geological Survey, in preparing the International Review regional books of Volume III of the Minerals Yearbook, extensively use statistics and data on mineral production, consumption, and trade provided by various foreign Government minerals and statistical agencies through various official publications. The cooperation and assistance of these organizations are gratefully acknowledged. Statistical and informational material was also obtained from reports of the U.S. Department of State, United Nations publications, and the domestic and foreign technical and trade press. Of particular assistance were reports submitted by the Resource Reporting Officers and other officers of the Department of State in U.S. Embassies worldwide. Their contributions are sincerely appreciated. Internal statistical support was provided by the staff of the Data Collection and Coordination Section of the Minerals Information Team.

The regimes of some countries reviewed in this volume may not be recognized by the U.S. Government. The information contained herein is technical and statistical in nature and is not to be construed as conflicting with or being contradictory of U.S. foreign policy.

John H. DeYoung, Jr.
Chief Scientist, Minerals Information Team

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THE MINERAL INDUSTRIES OF AFRICA

By George J. Coakley, Bernadette Michalski,¹ and Philip M. Mobbs

The civil wars, internal conflicts, and armed border conflicts that continued to destabilize a number of African countries constrained new investment in mineral exploration and development. Countries affected in 1998 included Algeria, Angola, Cameroon, the Republic of the Congo [Congo (Brazzaville)], the Democratic Republic of the Congo [Congo (Kinshasa)], Eritrea, Ethiopia, Guinea, Guinea-Bissau, Liberia, Nigeria, Rwanda, Sierra Leone, Somalia, Sudan, and Uganda. In Zimbabwe, increasing economic problems, which included high inflation and currency devaluations, were a disincentive to new investment. A December 1998 report by the Joint United Nations Program on HIV/AIDS, which is accessible at URL <http://www.who.int/emc-hiv>, highlighted the seriousness of the AIDS epidemic in Africa. In several southern African countries from 20% to 25% of the working age population is infected. The long-term implications of the AIDS epidemic on the workforce presents another disincentive to foreign investment and economic development in the region. AIDS also has the potential to increase operating costs to the mining sector in many countries where the social welfare and health-care costs of employees are absorbed by the mining companies.

New mining laws were put in place in Botswana, Sierra Leone, and Tanzania. Efforts to revise mining legislation were underway in Congo (Kinshasa) in spite of an ongoing civil war and in South Africa and Uganda. In South Africa, the Minerals & Mining Policy White Paper issued in October will lead to the first major post-Apartheid change in mineral policy. The White Paper proposed vesting mineral rights in the State and introducing a "use-it-and-keep-it" principle for mineral rights designed to free up unused mineral rights for new foreign investors and for new local black economic empowerment groups. The Government planned to use tax-based disincentives or other lease performance standards rather than expropriation to free up unused mineral rights, but final policies were still under discussion. Also during 1998, most of the corporate restructuring of South African mining investment houses {Anglo American Corp. of South Africa Ltd. (AAC) [including Johannesburg Consolidated Investment Ltd.], Gold Fields of South Africa Ltd. (GFSa), Gencor Ltd. [formerly General Mining and Finance Corp.], Rand Gold and Exploration Co. [formerly Rand Mines], and Anglovaal Ltd.} was completed putting in place an entirely new industry structure in South Africa. The corporate restructuring or "unbundling" was aimed at simplifying a complex system of interlocking ownership, establishing separate core-commodity-focused profit centers, and diversifying and rationalizing nonperforming assets to make the newly restructured companies more competitive internationally. The major changes included

the merger of AAC and Minorco S.A., its international subsidiary, to form Anglo American plc and the move of its corporate headquarters from Johannesburg to London. Anglo American, then established separate operating units for gold (AngloGold Ltd.), platinum (Anglo American Platinum Corp. Ltd.), coal (Anglo American Coal Corp. Ltd.), and base metals (Anglo American Base Metals). The megamerger of GFSa and Gencor that created Gold Fields Ltd. was finalized in February 1998, GFSa sold off most of its nongold mineral assets as part of the restructuring. In June 1998, JCI Gold created three separate and independent operating companies, Western Areas Ltd, Randfontein Estates Ltd., and Consolidated African Mines. Western Areas included Barnato Exploration Ltd. and the South Deep gold project. In November 1998, a 50% interest in Western Areas was sold to Placer Dome Inc., the Canadian gold company, for around \$235 million. Rand Gold and Exploration Co., formed in July 1997 from Rand Mines Ltd. to acquire and rehabilitate marginal cost mines, restructured its holdings into Durban Roodepoort Deep Ltd. and into the London-listed Randgold Resources Ltd., which maintained an exploration and mining program in seven other African countries, including the Syama gold mine and the Loulo gold development in Mali, and development of the Golden Ridge gold mine in Tanzania. During 1998, Harmony Gold Mining Co. Ltd., which was spun off by Rand Gold and Exploration Co. in 1997 as an independent company, continued to build up its gold production and resource base through the acquisition of mining assets being sold off by the major mining houses.

International exploration companies, in general, were cutting exploration expenditures back, some down to the minimum required to hold leases. According to the Metals Economics Group (1998), exploration expenditures in Africa, in line with the worldwide trend, declined by 25% to \$494 million in 1998 from \$662 million in 1997. The difficulty in raising new equity capital for exploration companies, following the Bre-X gold stock scandal in 1996, particularly by the junior exploration led to an exodus of some companies from Africa and a search by others for joint ventures with the major mining companies.

Affected by depressed world mineral commodity prices and the widespread civil unrest, African mineral production was generally in decline in 1998. In countries where currency devaluations were significant, especially in South Africa, low international commodity prices were offset by higher local currency returns and allowed some marginal operations to remain in production. Africa, however, continued to play an important role in world markets for a number of mineral commodities (table 1). Africa accounted for from 1% to 6% of world supply for aluminum, cement, coal, copper, graphite, iron

¹Deceased.

ore, lead, steel, and zinc; from 11% to 31% of world supply for bauxite, cobalt, gold, manganese, petroleum, phosphate, and uranium; and from 50% to 57% of chromium and diamonds. In addition to the commodities shown in table 1, South Africa alone accounted for 76% of the world supply of vermiculite, 62% of vanadium, 59% of aluminosilicates (andalusite and kyanite), 43% of platinum-group metals, 26% of zirconium minerals, and 23% of titanium minerals. For many of these commodities, Africa also held a comparable share of the world mineral reserve base.

In the gold sector, South Africa, which accounted for 19% of world gold production, produced 464 metric tons (t) of gold in 1998. This decline from 1997 was attributed to the rationalization and closure, sale, or reduced production from higher cost gold mines during the major restructuring of the South African gold industry in 1998. In the aluminum sector, production in Africa dropped by 10,000 t from the 1.1-million-metric-ton (Mt) level of 1997, with the energy crisis in Ghana accounting for much of the decline as Kaiser Aluminum Corp.'s aluminum smelter was able to operate at only 20% of capacity (table 1). Copper and cobalt production, principally from Congo (Kinshasa) and Zambia, continued their decline (table 1). The ongoing privatization of the copper industry in Zambia, however, was expected to begin reversing this decline within 3 to 4 years. Production of iron ore and steel, chiefly in South Africa and Zimbabwe, was hurt by the Asian financial crisis and the drop in world demand and dropped slightly in 1998, and production of ferrochromium, ferromanganese, and ferrosilicon alloys increased to 6% from 4% in 1997. The export of excess South African steel products into a stronger U.S. market led to antidumping actions by the United States against South Africa and several other countries. Coal and titanium production, primarily in South Africa, increased in 1998, and production of platinum-group metals (PGM) in South Africa and Zimbabwe increased in response to a decline in PGM exports from Russia. Despite weak markets, diamond production held steady in Botswana and South Africa, and new offshore marine production in Namibia and new alluvial production in Angola accounted for increased production in both countries. An armed attack on the new Yetwene Mine of Diamond Works Ltd. of Canada in Angola in November 1998 set back hopes for diamond production expansion in that country. The diamond mining areas of Mbuji-Maya in Congo (Kinshasa) remained a center of armed conflict, but did not appear to reduce significantly that country's normal production levels of more than 20 million carats per year.

The most significant development in the African aluminum industry was the June ground-breaking on Billiton plc.'s new \$1.3 billion Mozambique Aluminum Ltd. (MOZAL) aluminum smelter at Maputo, Mozambique. MOZAL will initially have a capacity of 245,000 metric tons per year (t/yr) of aluminum and will be doubled to 490,000 t/yr at a later date (Billiton plc, 1998, The Mozal Project, accessed February 2, 1999, at URL <http://www.mozal.com>). In Ghana, Kaiser reached an agreement with the Government to increase its allocation of power from the Akosombo Dam, thus allowing the company to increase operations from one to three of its five potlines at its 200,000-t capacity Volta Aluminum Co. Ltd. aluminum smelter at Tema (Kaiser Aluminum Corp., 1999, Form 10-K, 1998, to U.S. Securities and Exchange Commission, accessed October

12, 1999, at URL <http://www.sec.gov/Archives/edgar/data/811596/0000811596-99-000004.txt>). In Guinea, the Government was attempting partial privatization of the Frigua bauxite mine and alumina refinery.

Efforts to privatize and rehabilitate state-owned copper-cobalt mining companies in the Copperbelt of Congo (Kinshasa) and Zambia faced major setbacks during 1998. During 1996 and 1997 in Congo (Kinshasa), the state-owned La Générale des Carrières et des Mines (Gécamines) had successfully attracted a number of American, Australian, European, and South African companies to joint-venture arrangements to revitalize Gécamines' copper and cobalt operations in Shaba Province. The outbreak of a new civil war in 1998, however, put much of the redevelopment effort on hold.

Operational and financial problems at Zambia Consolidated Copper Mines Ltd. (ZCCM) led to a further 20% decrease in copper-production levels during 1998. By yearend, the company was forced to seek financial assistance from the Government to avoid the threat of bankruptcy. The sale of the Nchanga and the Nkana Divisions failed after the Government rejected the Kafue Consortium's offer to invest more than \$1 billion in the operations (Times Zambia Digest, April 7, 1998, ZCCM—The inside story, accessed May 1, 1999, at URL <http://www.zamnet.zm/zamnet/times/zamdigest.htm>). These Divisions represented more than one-half of ZCCM production capacity and included five underground mines, one open pit mine, associated concentrator facilities, a tailings leach plant, a copper smelter, a copper refinery, an acid plant, and a cobalt plant. Elsewhere in Zambia, Colossal Resources Corp. of Canada shut down its Kabwe cobalt tailings retreatment plant after only 1 year of operation, owing to poor economics.

In a surprise move, Gold Fields closed its copper and lead mining and smelting operations in Namibia and laid off around 2,000 workers at the Tsumeb mine tailings retreatment area and at the Khusib Springs, the Kombat, and the Ojithase Mines. The Namibian Government began efforts to attract new investors to take over these operations. In other copper developments, Namibia Copper Joint Venture (Pty.) Ltd., which was a partnership of Namibia Copper Mines Inc. of the United States (80%) and Great Fitzroy Mines NL of Australia (20%), proceeded with feasibility studies on developing the Haib porphyry copper deposit.

The sharp drop in demand and prices for diamonds, which was attributed, in part, to the financial crisis in Asia, led De Beers Consolidated Mines Ltd. to begin cutting back production at some existing South African operations by yearend. New diamond exploration and mining operations continued, with some exceptions, in Angola, Botswana, Mauritania, and Namibia. In 1998, the Mbala diamond mine in the Central African Republic and the River Ranch diamond mine in Zimbabwe were shut down.

In two yearend moves, Billiton and Anglo American cemented their role as major players in the world ferroalloys industry by joint venturing to purchase outstanding minority shares of Samancor Ltd.'s South African ferrochromium operations for \$200 million and by purchasing the manganese operations of The Broken Hill Proprietary Co. Ltd. (BHP) of Australia for \$375 million. The acquisition will give Billiton a 60% equity interest and Anglo American 40% in both mining and ferroalloy companies. Billiton's main competitor in the

ferroalloys industry has now become the Swiss-owned Sudelektra S.A., in which Glencore International, the Swiss metals trading company, was a major shareholder. Sudelektra acquired Chromecorp Holdings Ltd. and Consolidated Metallurgical Industries in 1998, thus essentially shifting the majority ownership of the South African ferroalloys industry to Europe. Billiton and Sudelektra, as the world's two largest producers, now each controlled more than 1 Mt of ferrochrome capacity. Sudelektra, which had previously acquired Rhombus Vanadium Holdings Ltd., the South Africa vanadium producer, was also South Africa's second largest vanadium pentoxide producer after Highveld Steel and Vanadium Corp. Ltd.

Gold continued to be the major focus of exploration and new mine development in Africa during 1998 with several new mines coming on-stream. These included the \$15 million rehabilitation and reopening of the Poura gold mine in Burkina Faso. Ashanti Goldfields Co. Ltd. of Ghana opened the redeveloped Bibiani Mine in Ghana for \$83 million and the \$55 million Siguiri gold mine in Guinea. New gold projects began at the Damang, the Tarkwa, and the Wassa Mines in Ghana and the Golden Pride Mine in Tanzania. At yearend, Sutton Resources Ltd. was working on project financing for the Bulyanhulu deposit, which was the largest gold deposit discovered to date in Tanzania, with reported measured, indicated, and inferred resources of 17.55 Mt grading 13.14 grams per metric ton (Sutton Resources Ltd., March 26, 1998).

In South Africa, where the extreme depths of new deposits adds several years to underground development time, four major new gold projects continued on track—Avgold Ltd.'s Target project, Western Areas's South Deep project, AngloGold Ltd.'s Moab project, and Gold Fields's developing Oryx mine. Elsewhere in Africa during 1998, the Afema gold mine in Cote d'Ivoire and the Dalny gold mine in Zimbabwe were closed, and the Freda Rebecca gold mine in Zimbabwe shifted operations from open pit to underground.

The highlight of the South African steel industry in 1998 was the commissioning of the \$1.4 billion steel plant at Saldanha Bay. A joint venture between Iscor Ltd. and the Industrial Development Corp. of South Africa (IDC), Saldanha Steel (Pty.) Ltd. will have a production capacity of 1.25 million metric tons per year of hot-rolled coil steel, targeted primarily for export markets. Weak global steel markets, particularly in Asia, forced other South African producers to cut back on production by yearend. During the year, Iscor decommissioned its 45-year-old Hot Strip Mill South and Blast Furnace B at its Vanderbijlpark Works and mothballed the ironmaking facilities at its Pretoria Works. Highveld also closed two of its seven steel-processing furnaces.

In separate but related actions, Iscor settled a longstanding dispute over mineral rights at its Rosh Pinah zinc mine in Namibia and purchased the remaining interest in the Zinc Corp. of South Africa Ltd. (Zincor) smelter. The mine's corporate name will change from Imcor Tin (Pty.) Ltd. to Rosh Pinah Zinc Corp. (Pty.) Ltd. Rosh Pinah zinc concentrates were exported to the Zincor smelter in South Africa for refining. Also in Namibia during 1998, Reunion Mining plc. of the United Kingdom, completed its feasibility study on the Scorpion zinc deposit. With a commitment to develop the mine, Reunion

will earn a 60% interest in the project from Anglo American.

In South Africa, Anglo American consolidated its position in the lead-zinc industry by purchasing base metals producer Black Mountain Mineral Development Co. (Pty.) Ltd. from Gold Fields and Phelps Dodge Corp. Anglo American announced plans to invest \$700 million to develop the Gamsberg zinc mine, mill, and smelter project. The Gamsberg deposit, in Northern Cape Province, contains a resource of 90 Mt, grading about 6.4% zinc (David McKay, September 8, 1998, Anglo to develop R4billion zinc mine; Business Day Online (Johannesburg), accessed September 9, 1998, at URL <http://www.bday.co.za/98/0908/news/news2.htm>). Billiton's and IDC's plans to build a new zinc refinery at Ngqura Port, near Port Elizabeth, Eastern Cape Province, were set back in December when its Japanese partners, a consortium led by Mitsui Mining and Smelting Co., withdrew from the project. In Tunisia, the Bougrine lead and zinc mine was reopened under the new ownership of Breakwater Resources Ltd. of Canada following a 2-year closure. Full production at the rate of 83,000 t/yr of zinc concentrates and 10,000 t/yr of lead concentrates is expected by 1999.

Avmin Ltd.'s Nkomati nickel mine in South Africa continued on track during its first full year of production, yielding about 3,000 t/yr of nickel in concentrate. The Epoch nickel mine in Zimbabwe depleted its resource and was closed. In Tanzania, Anglo American continued to conduct exploration and feasibility studies on the Kabanga nickel project on behalf of Sutton Resources, its joint venture partner.

In 1998, Morocco continued to be one of the world's top three phosphate rock producers. Production accounted for about 16% of world supply and 31% of Morocco's export earnings.

Petroleum and natural gas projects were becoming of increased importance to the economies and the electrical power needs of Africa. New natural gas developments were underway or in advanced planning stages in Ghana, Egypt, Namibia, and Mozambique. Nigeria authorized a study on the feasibility of establishing a natural gas pipeline to distribute Nigerian gas throughout West Africa. In Angola in 1998, major world-class deep-water petroleum discoveries by consortiums led by Chevron Corp. and Exxon Corp., both of the United States, along with the 1997 discoveries by Elf Aquitaine Group of France, will contribute to a tripling of Angolan oil production to more than 2 million barrels per day in the next 5 years. By 2003, Angola could rival Nigeria as Africa's largest oil producer. During 1998, Algeria's Société Nationale pour la Recherche, la Production, le Transport, la Transformation, et la Commercialisation des Hydrocarbures (SONATRACH) announced the discovery of 14 new oil and natural gasfields—2 by SONATRACH and others by such foreign operators as Anadarko Petroleum Corp. of the United States; BHP; LL&E Algeria Ltd., a subsidiary of Burlington Resources Inc. of the United States; Neste Oy of Finland; and Petro-Canada.

Reference Cited

Metals Economics Group, 1998, Overview of worldwide exploration budgets: Metals Economics Group Strategic Report, September-October, p. 1-5.

TABLE 1
AFRICA: PRODUCTION OF SELECTED MINERAL COMMODITIES, 1998 1/

(Thousand metric tons gross weight unless otherwise specified)

Country	Aluminum	Bauxite	Cement e/	Chromite	Coal, anthracite and bituminous	Cobalt, mine Co content (metric tons)
Algeria	--	--	7,500	--	--	--
Angola	--	--	350 3/	--	--	--
Benin	--	--	500	--	--	--
Botswana	--	--	--	--	780 e/	335 3/
Burkina Faso	--	--	--	--	--	--
Burundi	--	--	--	--	--	--
Cameroon	88	--	400	--	--	--
Central African Republic	--	--	--	--	--	--
Congo (Brazzaville)	--	--	10	--	--	--
Congo (Kinshasa)	--	--	100	--	5	1,500
Cote d'Ivoire	--	--	650	--	--	--
Egypt	230 3/	--	19,230 3/	1	300 e/	--
Equatorial Guinea	--	--	--	--	--	--
Eritrea	--	--	45	--	--	--
Ethiopia	--	--	775	--	--	--
Gabon	--	--	196	--	--	--
Ghana	56 3/	650	2,000	--	--	--
Guinea	--	15,000	--	--	--	--
Kenya	2	--	1,200	--	--	--
Liberia	--	--	10	--	--	--
Libya	--	--	3,000	--	--	--
Madagascar	--	--	120	140 p/	--	--
Malawi	--	--	175	--	65	--
Mali	--	--	10	--	--	--
Mauritania	--	--	50	--	--	--
Morocco	--	--	7,200	--	269	230 3/
Mozambique	--	6	290	--	100	--
Namibia	--	--	--	--	--	--
Niger	--	--	30	--	145	--
Nigeria	20	--	2,700	--	30 e/	--
Rwanda	--	--	10	--	--	--
Senegal	--	--	1,000	--	--	--
Sierra Leone	--	--	100	--	--	--
Somalia	--	--	--	--	--	--
South Africa	693 3/	--	9,500 3/	6,480	224,385	435
Sudan	--	--	380	20 e/	--	--
Swaziland	--	--	--	--	410	--
Tanzania	--	--	1,200	--	35	--
Togo	--	--	565	--	--	--
Tunisia	--	--	4,590 3/	--	--	--
Uganda	--	--	210	--	--	--
Zambia	--	--	351	--	50	5,011
Zimbabwe	--	--	1,100	605 e/	4,575	137
Total, Africa 4/	1,089	15,656	65,547	7,246	231,149	7,648
Total, world	22,100	122,000	1,519,000	13,503	4,229,169	26,300
Share of world total	5%	13%	4%	54%	5%	29%
United States	3,600	NA	85,222	--	1,003,591	--

See footnotes at end of table.

TABLE 1--Continued
AFRICA: PRODUCTION OF SELECTED MINERAL COMMODITIES, 1998 1/

(Thousand metric tons gross weight unless otherwise specified)

Country	Copper, mine Cu content	Diamond (thousand carats) e/ 2/	Gold e/ (kilograms)	Graphite	Iron ore	Lead, mine Pb content (metric tons)
Algeria	--	--	--	--	1,783	730
Angola	--	2,764 3/	--	--	--	--
Benin	--	--	--	--	--	--
Botswana	25	19,772 3/	1 3/	--	--	--
Burkina Faso	--	--	1,100	--	--	--
Burundi	--	--	5	--	--	--
Cameroon	--	--	1,000	--	--	--
Central African Republic	--	530	100	--	--	--
Congo (Brazzaville)	--	--	10	--	--	--
Congo (Kinshasa)	35	24,500	134	--	--	--
Cote d'Ivoire	--	310	1,500	--	--	--
Egypt	--	--	--	--	3,001	--
Equatorial Guinea	--	--	--	--	--	--
Eritrea	--	--	573	--	--	--
Ethiopia	--	--	2,500	--	--	--
Gabon	--	500	70	--	--	--
Ghana	--	809 3/	72,541 3/	--	--	--
Guinea	--	400	14,000	--	--	--
Kenya	--	--	388 3/	--	--	--
Liberia	--	300	800	--	--	--
Libya	--	--	--	--	--	--
Madagascar	--	--	50	13	--	--
Malawi	--	--	--	--	--	--
Mali	--	--	25,000	--	--	--
Mauritania	--	--	--	--	11,400	--
Morocco	8 e/	--	450	--	6	79,300
Mozambique	--	--	17 3/	6	--	--
Namibia	21	1,467 3/	1,882 3/	--	--	13,303
Niger	--	--	1,000	--	--	--
Nigeria	--	--	10	--	--	--
Rwanda	--	--	26	--	--	--
Senegal	--	--	--	--	--	--
Sierra Leone	--	250	15	--	--	--
Somalia	--	--	--	--	--	--
South Africa	166	10,756 3/	464,216 3/	--	32,965	84,128
Sudan	--	--	5,000	--	--	--
Swaziland	--	70	--	--	--	--
Tanzania	--	93	720	--	--	--
Togo	--	--	--	--	--	--
Tunisia	--	--	--	--	220	4,272
Uganda	--	--	2,500	--	300	--
Zambia	280 e/	--	765	--	--	--
Zimbabwe	4 e/	29 3/	25,175 3/	14	372	--
Total, Africa 4/	539	62,550	621,548	33	50,047	181,733
Total, world	12,200	114,938	2,480,000	683	1,020,935	3,100,000
Share of world total	4%	54%	25%	5%	5%	6%
United States	1,860	4	366,000	--	62,931	493,000

See footnotes at end of table.

TABLE 1--Continued
AFRICA: PRODUCTION OF SELECTED MINERAL COMMODITIES, 1998 1/

(Thousand metric tons gross weight unless otherwise specified)

Country	Manganese ore	Petroleum, crude (thousand barrels)	Phosphate rock e/	Steel, crude e/	Uranium, concentrate U ₃ O ₈ 5/ (metric tons)	Zinc, mine Zn content (metric tons)
Algeria	--	454,750	1,155 3/	400 3/	--	4,555
Angola	--	268,275	--	--	--	--
Benin	--	200 e/	--	--	--	--
Botswana	--	--	--	--	--	--
Burkina Faso	1 e/	--	--	--	--	--
Burundi	--	--	--	--	--	--
Cameroon	--	45,000	--	--	--	--
Central African Republic	--	--	--	--	--	--
Congo (Brazzaville)	--	98,550 e/	--	--	--	--
Congo (Kinshasa)	--	10,950	--	--	--	1,234
Cote d'Ivoire	--	7,300 e/	--	--	--	--
Egypt	10	316,090	1,050 3/	2,800 3/	--	--
Equatorial Guinea	--	30,000	--	--	--	--
Eritrea	--	--	--	--	--	--
Ethiopia	--	--	--	--	--	--
Gabon	2,092	132,000	--	--	862	--
Ghana	537	2,190	--	25	--	--
Guinea	--	--	--	--	--	--
Kenya	--	--	--	25	--	--
Liberia	--	--	--	--	--	--
Libya	--	502,970	--	--	--	--
Madagascar	--	--	--	--	--	--
Malawi	--	--	--	--	--	--
Mali	--	--	--	--	--	--
Mauritania	--	--	--	--	--	--
Morocco	28	35	23,587 3/ 6/	7	--	112,000
Mozambique	--	--	--	--	--	--
Namibia	--	--	--	--	3,257	42,142
Niger	--	--	--	--	4,400	--
Nigeria	--	788,000	--	--	--	--
Rwanda	--	--	--	--	--	--
Senegal	--	1 e/	1,320	--	--	--
Sierra Leone	--	--	--	--	--	--
Somalia	--	--	--	--	--	--
South Africa	3,044	6,549	2,739	7,506	1,134	69,630
Sudan	--	1,200	--	--	--	--
Swaziland	--	--	--	--	--	--
Tanzania	--	--	2	--	--	--
Togo	--	--	1,900	--	--	--
Tunisia	--	27,776	7,901 3/	122 3/	--	31,368
Uganda	--	--	--	15	--	--
Zambia	--	--	--	--	--	--
Zimbabwe	--	--	91	220	--	--
Total, Africa 4/	5,712	2,691,836	39,745	11,120	9,653	260,929
Total, world	18,700	24,441,130	145,000	781,000	40,016	7,540,000
Share of world total	31%	11%	27%	1%	24%	3%
United States	--	2,281,980	44,200	98,600	2,208	755,000

e/ Estimated. p/ Preliminary. NA Not available.

1/ Data may be different from that appearing in individual country production tables owing to availability of more current data. Table includes data available through March 1, 2000.

2/ Excluding synthetic diamond.

3/ Reported figure.

4/ May not add to totals shown because of independent rounding.

5/ Source: The Uranium Institute, London, England, written commun., 1999.

6/ Includes production from Western Sahara.

THE MINERAL INDUSTRY OF

ALGERIA

By Bernadette Michalski¹

In 1998, the nation's leading mineral sector, petroleum and natural gas, accounted for 95% of export revenues, or \$9.8 billion compared with \$13.6 billion in 1997 owing to lower oil prices (Arab Petroleum Research Center, 1999, p. 57). Production of metals and industrial minerals was modest. The Government's development priorities included expanding exploration activities, improving the recovery rate of oil and gas, augmenting hydrocarbon reserves, and increasing hydrocarbon production, transport, and export capacities. Although several exploitable mineral deposits have been identified by the Office de la Recherche Géologique et Minières, they were located in remote areas lacking infrastructure. A production-sharing agreement with Atlantic Richfield Co. (ARCO) of the United States was Algeria's first association with a foreign partner in exploiting a producing field, the Rhourde El Baguel. The agreement permits ARCO to receive up to 49% of the field's output. The field was expected to reach peak production of 125,000 barrels per day (bbl/d) by 2000.

Since the decree of April 6, 1996, a foreign company engaged in hydrocarbon exploration and development is no longer required to form a commercial company subject to Algerian law with headquarters in Algiers if it sets up a joint stock company with the Government's Société Nationale pour la Recherche, la Production, le Transport, la Transformation, et la Commercialisation des Hydrocarbures (SONATRACH). If a field has not yet been developed or is under development, then the foreign company is required to pay a bonus to access reserves. If a foreign company finances a pipeline, then priority will be given to transporting hydrocarbons from the field operated by that company. SONATRACH's foreign partners have the right to use the proceeds of natural gas exports covered by joint marketing agreements with SONATRACH. The foreign partners are not required to return their share of proceeds from these sales to Algeria.

In 1998, crude oil production was 816,000 bbl/d, lease condensates were produced at an average of 430,000 bbl/d, and natural gas plant liquids averaged 155,000 bbl/d (Energy Information Administration, 1999). A variety of nonfuel minerals were produced in minor amounts, but only iron ore, mercury, and phosphate rock outputs were significant. All iron ore produced was consumed domestically. Phosphate rock and mercury were produced entirely for export. Algerian production of mercury has fluctuated widely along with the price of this commodity in the world market. (See table 1.)

Natural gas and liquid fuels accounted for the bulk of Algeria's export earnings. Exports of natural gas totaled 52.41 billion cubic meters in 1998. Italy continued to be the principal

market for Algerian natural gas, followed, in decreasing order of volume, by France, Spain, Belgium, Turkey, and others. Algeria's share of the European gas market ranks third behind Russia with 36% and the Netherlands with 26%. Liquefied natural gas (LNG) exports were directed principally to Europe and the United States. In 1998, the United States imported 1.95 billion cubic meters of LNG from Algeria, representing a 5% increase over 1997 imports and nearly double the amount of LNG imported from Algeria in 1996. Two-thirds of the Algerian LNG arriving in the United States was received at the Distrigas Corp. terminal north of Boston at Everett, Massachusetts. The remaining LNG was received at the Trunkline LNG Co. terminal at Lake Charles, Louisiana. Most of Algeria's natural gas exports were sourced from the Hassi R'Mel Field (Energy Information Administration, 1999c).

In 1998, about 260 million barrels (Mbbbl) of Algerian crude oil and refined products were exported to Western Europe and 105 Mbbbl were exported to the United States. Nearly one-half of the U.S. imports from Algeria were slated as feedstock for the petrochemical industry (Energy Information Administration, 1999b). Algeria's nonfuel mineral exports included helium, iron ore, metals, liquid and gaseous nitrogen, and phosphates. Algeria imported about 750,000 metric tons (t) of cement in 1998, a significant increase compared with 430,000 t in 1997. Major sources of imported cement were Spain, Tunisia, and Turkey.

Algeria's overall foreign trade surplus fell dramatically in 1998 to \$79 million compared with \$5.79 billion in 1997. Any decline in oil prices had serious implications for the Government's domestic finances. The average spot price for Algeria's Saharan Blend crude oil was \$13.07 per barrel in 1998 compared with \$19.62 per barrel in 1997.

Entreprise d'Exploitation des Mines d'Or (ENOR), the state gold development company, initiated fund raising for the development of the Tamesmessa and the Tirek gold deposits in southern Algeria. Government funding for the ENOR project will come from SONATRACH and the Algerian Central Bank, \$6 million each; SAA (Algeria's insurance company), \$3 million; and ENOF, \$1.5 million. Completion of the project was expected to cost \$40 million. Foreign capital was expected to finance the remaining \$23.5 million (OPEC Bulletin, 1997).

The bulk of Algeria's iron ore output was extracted from the mine at Ouenza. Mining operations were spread over 17 square kilometers with the main orebody 2 kilometers (km) long and 500 meters wide (Mine & Quarry, 1989). Iron ore also was mined at Bou Khadra and shipped with Ouenza ore by rail to the El Hadjar processing plant, near Bejaia, a distance of 170 km. Both mines were operated by Entreprise Nationale de Fer et de

¹Deceased.

Phosphates.

Production of cement was obtained from 12 subsidiaries of a newly created holding company, Batiment et Matériaux de Construction. The plants had a combined total capacity of 10.55 million metric tons per year (Mt/yr) of clinker and 12.35 Mt/yr of cement. Capacity utilization is a little more than 60% with improvement to 70% anticipated in 1999.

The fertilizer industry, based on indigenous natural gas, had the capacity to produce 990,000 metric tons per year (t/yr) ammonia, 825,000 t/yr ammonium nitrate, 660,000 t/yr nitric acid, and 550,000 t/yr nitrogenous fertilizers.

Helium was produced at the Helios Co.'s Bethiou plant near Arzew. SONATRACH owned a 51% equity in the company, and Air Products & Chemicals, Inc. of the United States and L'Air Liquide of France shared the remaining equity. Virtually all production was exported to Europe. The plant's capacity was 16 million cubic meters per year of liquid helium, accounting for 20% of world output and 33,000 t/yr of liquid and gaseous nitrogen. The possible construction of the nation's second helium plant is under consideration.

In 1998, SONATRACH announced the discovery of 14 new fields—2 by the state-owned company and others by foreign operators, including Anadarko Petroleum Corp. of the United States; the Broken Hill Proprietary Co. Ltd. of Australia; LL&E Algeria Ltd., a subsidiary of Burlington Resources Inc. of the United States; Neste Oyj of Finland; and Petro-Canada. New discoveries were made principally in the Illizi and Berkine Basins (Arab Petroleum Research Center, 1999, p. 19).

Anadarko brought the Hassi Berkine South Field in Block 404 on-stream in early May 1998, producing 60,000 bbl/d by midyear from nine wells linked to a central processing facility. The crude oil was slightly heavier than Saharan Blend at 42° API but was lower in sulfur. Full-field development plans called for 150,000 bbl/d from 50 wells. This represented Anadarko's first production in Algeria where it has made a total of 14 discoveries. In the exploitation phase, concession partners reduced their equity by about 50% to accommodate SONATRACH at 51%. Anadarko retained 24 % equity interest; Lasso plc of the United Kingdom, 12%; and Mærsk Olie og Gas AS of Denmark, 12.5 % (Middle East Economic Digest, 1998).

In 1998, gross production of natural gas was nearly 129 billion cubic meters, about 50% of which was reinjected to maintain petroleum reservoir pressure. The combined total production of LNG at the three liquefaction plants at Arzew and the one at Skikda was about 41 million cubic meters (Arab Petroleum Research Center, 1999, p. 49). The addition of 15.5 billion cubic meters per year capacity to Algeria's natural gas export lines was proposed—an increase of 6 billion cubic meters for the Trans-Med line and 9.5 billion cubic meters for the Maghreb-Europe line (Petroleum Economist, 1998).

Repsol of Spain was committed to invest \$540 million during the coming 5 years to implement three hydrocarbon projects and one petrochemical project. The investment included the development of the Tin Fouye Tabankort natural gas field; the development of the Tifemine Oilfield, which came on-stream in late 1998; and the petrochemical plant to be built at Skikda by Société Méditerranéenne des Polymères (Middle East Economic Digest, 1998b). Most of Algeria's crude oil production of 298 Mbbl was derived from the Hassi Messaoud and the Haoud El

Hamra Fields in the Sahara and the Tin Fouyé Tabankort and the In Amenas Fields near the Libyan border.

The national petrochemicals company, Entreprise Nationale d'Industrie Petrochimique, established a joint venture with Repsol Quimica of Spain to construct linear low-density polyethylene, polyvinyl chloride, and high-density polyethylene plants. To support this development, the Algerian Government provided investment guarantees that include the provision of public utilities and raw materials, and preferential tax treatment.

Hydrocarbon reserves on January 1, 1999, were 4.1 trillion cubic meters of natural gas. Hassi R'Mel accounted for 58% of the natural gas reserve. Recoverable petroleum reserves were reported to be 10 billion barrels with the Hassi Messaoud accounting for 65% of the total. ARCO's use of in-fill drilling and miscible gas injection technology was expected to add 50 to 100 Mbbl to the Rhourde El Baguel Field's recoverable reserves by 2000 (Arab Petroleum Research Center, 1999, p. 17). Iron ore reserves are 3,500 million metric tons (Mt), lead/zinc ore at 1.6 Mt metal content, mercury at 37,000 t metal content, and gold at 110 t metal content (Mining Journal, 1999).

Algeria's railroad system, which totaled 4,060 km of track, and its road network, which covered more than 90,000 km, were in the northern section of the country and supported long-established mining and other export-oriented industries.

More than 11,400 km of pipeline served the hydrocarbon industries within Algeria. The center of the crude oil pipeline network was Hassi Messaoud, in the southeast, from which three crude lines ran north to Skikda, Bejaia, and Arzew. The center for the natural gas pipeline network was Hassi R'Mel, with pipelines connecting to liquefaction facilities at Arzew and Skikda. Hassi R'Mel was also the source for natural gas exports to southern Europe by means of the 24-billion-cubic-meter-per-year-capacity Trans-Mediterranean pipeline and the 8-billion-cubic-meter-per-year-capacity Maghreb-Europe pipeline. The Transmed natural gas export pipeline extended for 2,340 km from Algeria northeastward through Tunisia and under the Mediterranean Sea to Sicily and the Italian mainland. Natural gas was exported to Slovenia by means of a 35-km spur line near the Italian end of the Trans-Mediterranean pipeline. The 1,845-km Maghreb-Europe pipeline traverses Algeria northwestwards through Morocco and the Straits of Gibraltar to southern Spain. The pipeline was inaugurated in November 1996 at an initial capacity of 8 billion cubic meters per year. The second phase of the Maghreb-Europe pipeline construction will include extensions to Portugal, France, and Germany.

Algeria used seven marine terminals for the export of hydrocarbons, including La Skhirra, Tunisia. The largest terminal was Arzew-Bethioua, which accommodated 40% of all hydrocarbon exports. Port capacity at Skikda was limited to 90,000-cubic-meter (m³) LNG carriers. Efforts were underway to augment the port facilities to eventually accommodate 125,000-m³ LNG carriers.

Algeria's implementation of the International Monetary Fund economic structural reform proposals have resulted in a substantial deceleration of inflation, strengthening of the fiscal position, and further progress towards a market-oriented economy. In future years, recoverable hydrocarbon reserves should increase as a result of new discoveries, improved data on existing fields, and the installation of enhanced recovery systems.

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Major Sources of Information

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TABLE 1
ALGERIA: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity 2/ METALS	1994	1995	1996	1997	1998
Cadmium, refined e/	75 r/	75 r/	75 r/	75 r/	75
Iron and steel:					
Iron ore, gross weight thousand tons	2,047	2,200 r/	2,245	1,637 r/	1,783
Metal:					
Pig iron do.	919	940	800 e/	700 e/	700
Steel, crude do.	808	827	620 r/	427	400
Lead:					
Concentrate, Pb content	1,100	1,383	1,016	845 r/	730
Metal, refined	8,000	8,000	8,000	7,000 r/	7,000
Mercury kilograms	414,000	292,000	367,800	447,034 r/	223,965
Silver e/ do.	3,000	2,000	2,000 r/	1,600 r/	1,500
Zinc:					
Concentrate, Zn content	5,700	7,174	5,912	3,690 r/	4,555
Metal, smelter output e/	30,000 3/	30,000 3/	25,000	25,000	25,000
INDUSTRIAL MINERALS					
Barite, crude	20,584	29,838	31,348	39,140 r/	37,006
Cement, hydraulic	6,060	6,200 r/	6,500 r/	7,000 r/	7,500
Clays:					
Bentonite	20,215	17,088	17,200	17,657 r/	15,655
Fuller's earth	4,550	4,500	4,500 e/	3,960 r/	3,942
Kaolin	16,984	24,068	25,000 e/	18,533 r/	13,640
Diatomite	2,800	3,700	3,700 e/	2,332 r/	2,133
Feldspar e/	6,900 3/	7,000 3/	7,000	7,000	7,000
Gypsum e/ 4/ thousand tons	225 3/	250 3/	250	250	250
Helium, liquid e/ million cubic meters	-- 3/	10 3/	15	15	16
Lime, hydraulic e/	62,000	62,000	62,000	62,000 r/	62,000
Nitrogen, N content of ammonia	243,000	176,100	149,900	380,000 r/	350,200
Phosphate rock:					
Gross weight thousand tons	730	1,596	1,051	1,063 r/	1,155
P ₂ O ₅ content do.	251	500	320	330 r/ e/	358
Salt, brine and sea salt	178,000	178,000 r/ e/	178,000 r/ e/	137,317 r/	172,025
Sodium compounds, caustic soda e/	700	700	700	700	700
Strontium minerals, celestite, gross weight e/	5,400	5,400	5,400	5,400	5,400
Sulfur, elemental e/	20,000	20,000	23,000	23,000	23,000
MINERAL FUELS AND RELATED MATERIALS					
Gas, natural:					
Gross million cubic meters	131,100	114,779	143,100 r/	125,012 r/	125,971
Dry 5/ do.	51,100	58,100	62,300	97,458 r/	96,873
Natural gas plant liquids thousand 42-gallon barrels	51,500	53,000	53,000 r/	56,575	56,575
Petroleum:				r/	
Crude including condensate do.	430,700	438,730 r/	453,300	466,105 r/	454,750
Refinery products:					
Liquefied petroleum gas do.	9,500	10,000	60,000 r/	75,539 r/	86,048
Gasoline do.	18,900 e/	21,900	20,000 r/	17,313 r/	17,836
Naphtha do.	31,000	31,000	31,000	33,233 r/	31,688
Kerosene e/ do.	8,540 3/	8,030 3/	8,100	8,000 r/	8,000
Distillate fuel oil do.	49,800	51,976	50,000 r/	48,661 r/	46,245
Lubricants do.	825 e/	850	850 e/	686 r/	728
Residual fuel oil do.	37,400 e/	36,646	36,800 r/	37,002 r/	33,753
Other e/ do.	3,000	3,500	3,500	2,500 r/	2,000
Total do.	158,965 r/	163,902 r/	210,250 r/	222,934 r/	226,298

e/ Estimated. r/ Revised.

1/ Table includes data available through July 1, 1999.

2/ In addition to the commodities listed, secondary aluminum, secondary lead, and secondary copper may be produced in small quantities, and crude materials are produced for local consumption. Output is not reported, and available information is inadequate to make estimates of production levels.

3/ Reported figure.

4/ Includes about 50,000 metric tons per year of plaster.

5/ Excludes gas used in reinjection, flaring, venting, transmission losses, and natural gas liquids extraction.

THE MINERAL INDUSTRY OF

ANGOLA

By George J. Coakley

Angola had a population of about 11 million in a 1,246,700-square-kilometer (km²) area, which includes Cabinda, a 100-kilometer (km)-wide and 150-km-deep coastal strip located between the Republic of the Congo [Congo (Brazzaville)] and the Democratic Republic of the Congo [(Congo (Kinshasa))]. Cabinda was the source of about 70% of Angola's oil production. In 1998, the mineral economy of Angola was dominated by petroleum. The \$3.06 billion in petroleum exports, a 35% decline in value from 1997, accounted for 90% of all exports and for more than 80% of Government revenues. Angola's gross domestic product (GDP) was estimated, based on purchasing power parity, to be \$11 billion by yearend 1998, with petroleum and related services accounted for about 45% of the GDP (Central Intelligence Agency, 1999, Angola, The World Factbook, accessed November 11, 1999, at URL <http://www.odci.gov/cia/publications/factbook/ao.htm>).

Following more than 20 years of fighting, the country's lengthy civil war appeared to be resolved with the signing of the Lusaka Peace Protocol in 1994, and optimism that economic redevelopment would be fueled by new foreign investment in petroleum and mining was considerable by 1997. During 1998, however, the opposition forces of the National Union for the Total Independence of Angola (UNITA) failed to honor its obligations under the Lusaka Peace Protocol by not fully withdrawing its forces from areas occupied during the war, especially diamond mining areas, and by not fully cooperating in forming a new coalition government, the Government of Unity and National Reconciliation. As a result, renewed civil war broke out in the second half of the year, seriously affecting land-based mineral exploration and production operations, especially for diamonds. On June 12, 1998, the United Nations Security Council, through Resolution 1173 (1998), voted to impose additional sanctions on UNITA. The sanctions, which were adopted by the Security Council on June 12 and went into effect on June 25, ordered the freezing of financial resources or funds generated from property controlled by UNITA as an organization or by its leaders, their immediate families, and anyone acting on their behalf, and ban anyone from accepting or purchasing diamond exports from Angola except those with a certificate of origin from the Luanda Government. The importing of mining and transport equipment into UNITA-controlled areas was also banned (United Nations Security Council, June 12, 1998, Council to impose measures against UNITA, effective 25 June, unless it cooperates to extend State administration throughout Angola, press release SC/6530, accessed December 20, 1999, at URL <http://www.un.org/News/Press/docs/1998/19980612.sc6530.html>).

The highlight of the mineral industry for 1998 was the success of offshore deep-water petroleum exploration programs. Protected from the onshore civil war actions, the major oil companies reported nine significant new deep-water oil

discoveries during the year. Added to the three major discoveries in 1997, these new fields represent as much as 6 billion barrels of recoverable crude oil (Africa Energy & Mining, June 1999; U.S. Energy Information Agency, 1999, Angola, Energy Country Analysis Brief, accessed December 12, 1999, at URL <http://www.eia.doe.gov/emeu/cabs/angola.html>). Angola anticipated that between \$4 billion and \$5 billion per year will be invested in the country during the next 5 years to develop these offshore petroleum resources (Embassy of Angola, Washington, DC, 1999, Oil industry developments—Sonangol outlines future plans for the oil sector in Angola, O Pensador, September/October, accessed December 12, 1999, at URL <http://www.angola.org/news/pensador/october99/econ.html>).

Government Policies and Programs

Mining and petroleum development are governed by several legal statutes, most of which have been updated since 1992. They include Foreign Investment Law No. 15/94 of October 23, 1994, which empowered the Foreign Investment Center to reject or approve new investment applications within 45 to 90 days on investments of up to \$50 million. Investments of more than \$50 million must be evaluated and forwarded to a Ministry of Planning and Economic Coordination within 40 days and a Negotiating Commission established within another 15 days. The Law on Geological and Mining Activities (Mining Law) No. 1/92 of January 17, 1992, administered by the Ministry of Geology and Mines, established the legal framework for prospecting, mining, processing, marketing, suspension or exhaustion, and reclamation of mineral resources, including stockpiles and waste heaps from old mining. Mineral rights were vested in the State. The law eliminated the state monopoly on mineral rights and provided for granting prospecting licences and mining titles to state-owned, mixed, private, or joint mining companies. As of mid-1997, 44 prospecting licences and 138 mining titles had been granted under the 1992 mining law. A separate law on diamonds was promulgated on January 7, 1994, and granted exclusive mineral rights for diamonds to Empresa Nacional de Diamantes de Angola (Endiama), the state-owned diamond mining company.

The laws on privatization were established under Law No. 10/94 of 1994. Under Decree No. 4-B/96 of May 31, 1996, which established the rules for taxation for the mining industry, domestic and foreign investors are treated equally. Corporate taxation was set at 40% of the net profit. Royalty rates were set at 5% on precious stones and metals, 4% on semiprecious stones, 3% on metallic minerals, and 2% on other minerals. A surface tax of from \$1.00 to \$4.00 per square kilometer held was paid during exploration. Depreciation of fixed assets was allowed, and exploration costs can be written off during the first

3 years of the mining stage (Sambula, 1998). Petroleum exploration and development were administered under the Hydrocarbon Law of 1978, which made Sociedade Nacional de Combustiveis de Angola (Sonangol) the sole concessionaire for exploration and production. International oil companies operated in joint ventures or under production-sharing agreements with Sonangol.

Production and Trade

In 1998, Angola exported more than 268 million barrels of crude oil, of which 60% went to the United States. Angolan crude also was exported to Brazil and European and Asian markets. Disaggregated trade data for the current or recent few years were unavailable. Production of oil and gas continued on an upward trend, having increased by 37% between 1994 and 1999. Cement and reported diamond production increased, the latter reflecting the successful startup of several privatized operations from the active diamond fields in the northwestern provinces, prior to the renewed fighting between Government and UNITA forces.

Commodity Review

Industrial Minerals

The diamond areas in the Lunda Norte and the Lunda Sul Provinces, which were previously controlled by UNITA, and accounted for about \$400 million of Angola's annual national diamond output of \$1.1 billion, were opened to outside exploration and development companies in 1996. Some concession areas were not opened pending the full withdrawal of UNITA armed forces in 1997, while a number of operations were forced to suspend mining or close up completely, with the renewed outbreak of fighting, in 1998.

Sociedade Miniera de Catoca Ltda. (SMC) began production at the Catoca kimberlite pipe, 35 km south of Saurimo, in September 1997. By the end of 1998, the project had produced 1.245 million carats worth \$85 million. Catoca was the world's fourth largest kimberlite in terms of surface area and constituted the single largest diamond operation in Angola in terms of production value. SMC was a joint venture comprising Endiama (32.8%), Russia's Almazay Rossii-Sakha (32.8%), Brazil's Odebrecht Mining Services Inc. (18.4%), and Israel's Leve Leviev (16%). SMC produced between 80,000 and 90,000 carats per month at Catoca, and the output was expected to increase to 1.2 million carats in 1999 and 1.5 million carats in 2000. During 1998 and early 1999, SMC's operations were not impeded by UNITA operations in the area. To boost production at Catoca, SMC planned to invest an additional \$12 million during the next 2 years. After the first phase of the project ends in 2003, SMC planned to invest another \$250 million to \$300 million in a second phase, which should boost production to 5 million carats per year. Diamond reserves in the Catoca kimberlite were estimated be 40 million carats, but that number could change as additional tests are performed on the structure (Embassy of Angola, Washington, DC, 1999, Mining sector developments—Catoca diamond production expected to grow despite war, O Pensador, April 1999, accessed June 11, 1999, at URL <http://www.angola.org/news/pensador/april99/economic.html>).

html).

Sociedade de Desenvolvimento Mineiro de Angola, S.A.R.L. (SDM), a joint venture among Ashton Mining Ltd. of Australia, Endiama, and Odebrecht, was formed in 1995 to mine alluvial diamonds in the 85,600-km² Cuango River Valley concession, which is centered near the town of Luzamba in northeastern Angola. The first stage of development of the alluvial operations at the Tázua Mine and the final recovery plant at Luzamba was completed in 1998, with production beginning in August and the first parcel of 61,676 carats being sold to De Beers Central Selling Organization in London in December. For the third and fourth quarters of calendar year 1998, SDM produced 66,469.75 carats from 107,780 cubic meters of alluvial ore treated. Initial mining confirmed the high grade and diamond value projections of earlier studies, and the average value of diamonds sold was within the anticipated range of \$200 to \$350 per carat. Production from the river diversion at Tázua was expected to produce 250,000 carats in 1999; however, the project was set back by a January 7, 1999, ambush by an armed band, believed to be UNITA rebels, near the SDM operations in which two guards and two senior mine officials were killed (Ashton Mining Ltd., January 7, 1999, Ambush at Cuango Project, Angola, press release, accessed December 15, 1999, at URL http://www.ashton.net.au/news/99_01_angola.html; October 22, 1999, Cuango, 1998 annual report, accessed December 15, 1999, at URL <http://www.ashton.net.au/report/index98.html>). Security conditions remained a major concern and cost for the company.

DiamondWorks Ltd. of Canada (formerly Carson Gold Corp.) produced a total of 74,600 carats of diamonds in 1998 valued at \$10.96 million for an average price per carat of \$173 compared to 1997 production of 28,600 carats valued at \$5.16 million and an average price per carat of \$238. Production increases were accounted for by the first full year of operation of the Luo Mine, which yielded 54,500 carats, and 6-month startup output of the Yetwene Mine, which yielded 19,500 carats. An additional 600 carats came from exploration sampling of the Luarica concession. In June 1998, following a capital investment of \$12 million, DiamondWorks began commercial production of its second diamond property, the 550-km² Yetwene concession on the Chicapa and the Lumanha Rivers in Lunda Norte Province. In May 1997, DiamondWorks acquired a 50% interest in Yetwene by exercising agreements between DiamondWorks and Zizania Holdings Ltd. of the United Kingdom, the operator, along with a concurrent agreement between DiamondWorks' subsidiary, Branch Energy Ltd., and Sociedade Mineira do Lucapa and Sociedade Mineira e de Investimentos da Lunda, S.A., two Angolan companies. In 1996, Carson Gold and Branch Energy Ltd., its subsidiary, had acquired majority interest in reported resources of more than 10 million carats of diamond in the Luo and the Luarica concessions in Lunda Norte Province. Carson Gold was subsequently renamed DiamondWorks Ltd. of Canada in 1997 (DiamondWorks Ltd., June 27, 1996, Carson to become world player in diamond industry—Carson acquires major diamond concession in Africa, accessed June 3, 1997, at URL <http://www.diamondworks.com/news.html>). In late 1998, full-scale production began at Yetwene, and by November, the new diamond recovery plant was producing at its designed rate of between 10,000 and 12,000 carats per month. The company was forced to suspend

operations at Yetwene following an attack by a group of armed rebels on November 8, 1998, during which eight employees were killed and 8 more were taken hostage and are still missing. The company reported a long-term resource of 1.8 million carats of high quality diamonds at Yetwene, sufficient to maintain a production of 120,000 carats per year for 10 years. Subject to the availability of additional financing and increased political stability in Angola, DiamondWorks planned to add two additional diamond-processing plants to expand production capacity to 360,000 carats per year. The Luo Mine contained two of the world's largest kimberlite pipes, the Camatchia and the Camagico; production to date, however, has been restricted to the high-grade alluvial reserves in the adjacent Chicapa River. During 1999, mining efforts will shift from alluvial operations to mining of the kimberlite pipe at Camatchia. Production from Camatchia was expected to be 162,000 carats per year of diamonds with an average value between \$125 and \$150 per carat during 1999. (DiamondWorks Ltd., 1999, Review of operations, 1998 annual report, accessed December 15, 1999, at URL <http://www.diamondworks.com/s/FinancialInformation.asp?FinancialRptID=292>).

During 1998, SouthernEra Resources Ltd. of Canada recovered 144,500 carats of high-quality diamonds at its joint-venture alluvial and fluvial mining operations at the Cassanguidi and the Luo concessions, including a 100-carat stone that was sold for \$400,000. By ceasing alluvial operations at yearend owing to decreased recoveries of diamond, considerable increases in security costs, and logistical resupply problems, the company recorded a loss on discontinued operations of \$5.3 million. Work continued, however, on the Camafuca-Camazambo project. Preparatory work on the Camafuca kimberlite pipe in early 1998 included test plant design, site infrastructure development, and site preparation. By yearend, a bulk sample of more than 15,000 metric tons was excavated, and a processing plant was being assembled to process and confirm previous bulk sampling results and to recover a new diamond parcel for valuation (SouthernEra Resources Ltd., January 7, 1999, Angola alluvial mining operations discontinued, press release, accessed February 12, 1999, at URL <http://www.southernera.com/press/pr990107.html>; 1999, Angola—Operations overview, 1998 annual report, accessed December 12, 1999, at URL <http://www.southernera.com/1Exploration&Operations.htm>). In March 1997, the Angolan Council of Ministers had granted SouthernEra a 51% interest in a 160-hectare (ha) concession covering the Camafuca-Camazambo kimberlite pipe in the Calonda area of Lunda Norte Province. Camafuca has been described as one of the world's largest undeveloped kimberlite pipes. SouthernEra will acquire a 51% interest in the Camafuca project by buying out SAA Distributors (Pty) Ltd., one of its partners, with a final \$6.5 million payment by April 1999. Other partners included Endiama (20%); Sociedade Miniera Do Lucapa, S.A.R.L. (SML), (15%); and Consorcio Minera Camafuca Camazambo, S.A.R.L. (Comica), (7%).

In June 1998, De Beers Centenary Angola Properties Limited (DEBCAP), a subsidiary of De Beers Centenary AG, and Endiama awarded a contract to a Portuguese firm, Teixeira Duarte, to build a new diamond-sorting building behind the current Endiama headquarters in Luanda. De Beers will give 3 of the 12 floors of the \$30 million building to Endiama as their

property. The building will house secure diamond sorting facilities incorporating current De Beers' diamond technology and will be used to train Angolan citizens to sort and value rough diamonds. Work on the 2-year construction project began in mid-1998 (De Beers Centenary AG, June 3 1998, De Beers awards tender for new sorting facility in Angola, press release, accessed June 11, 1998, at URL <http://www.edata.co.za/debeers/press42.html>).

In May 1998, the association of Endiama/De Beers, a joint venture between De Beers Angola Prospecting, a wholly owned subsidiary of De Beers Consolidated Mines Ltd., and Endiama, announced the discovery of two new kimberlites in its concession area in the Lunda Sul Province. The first kimberlites to be discovered since independence in 1975, they lie to the north of the city of Saurimo in the vicinity of the Catoca Mine. The pipes were intersected below a considerable depth of postkimberlite sediments and were identified by using De Beers' most recently developed technology. The Lunda concession was one of three areas granted to the association Endiama/De Beers in June 1996, within which the association has the right to any new kimberlites found (De Beers Centenary AG, May 11, 1998, Joint press release between Endiama & De Beers on the discovery of new kimberlites in Angola, press release, accessed June 11, 1998, at URL <http://www.edata.co.za/debeers/press40.html>).

In May 1998, American Mineral Fields, Inc., of Canada, acquired the remaining 50% interest in International Defense and Security Forces Resources NV (IDAS) of the Netherlands Antilles and its Cuango Valley Luremo diamond concessions for \$2.5 million and a 30% net profit interest in production from the concessions up to a maximum of \$84 million. IDAS was a 50-50 joint-venture partner with Endiama, with respect to the mining lease in the Cuango Valley, and a 36,000-km² prospecting lease called the Cuango International, which borders the mining lease to the north. Development work on the Luremo River concession was delayed during the year, owing to the security situation in the area (American Mineral Fields, Inc., May 26, 1998, Purchase of IDAS Resources NV, press release, accessed December 22, 1999, at URL <http://www.am-min.com/98/may%2026-98.html>).

In March 1998, Trans Hex International Ltd. of South Africa, signed a definitive agreement with Longreach Gold Oil Ltd. of Australia for the exploration and development of three concession areas in the Lunda Norte Province. This agreement required Trans Hex International to fund the exploration and development of each of the three concession areas located on the Chicapa and the Luachimo Rivers in the Lucapa area, in Lunda Norte Province—Proesda blocks Y, AC, and P, known as Diagama, Somicoa, and Kupolu, (respectively) up to a maximum of \$1.5 million per concession in return for which it would acquire 75% of Longreach's interest. Longreach held a 50% interest in the concessions with the balance being held by Angolan nationals. Any additional financing required would be funded by Trans Hex and Longreach on a 75%-to-25% basis or result in dilution. The Diagama project required the commitment of significant resources to a project with an increasing cost profile, in which Trans Hex International had a low equity interest. In the light of the weak international demand for diamonds and the extremely high political and security risk in the area, Trans Hex International reevaluated its

exposure in Angola in November 1998 and terminated its agreement with Longreach and wrote down \$734,000 in exploration expenditures (Trans Hex International Ltd., March 31, 1999, Exploration—Angola, Notes to the 1999 consolidated financial statements, accessed December 22, 1999, at URL <http://www.transhex.com/financial-fr.htm>).

Fuels

Angola has been undergoing a major offshore petroleum exploration boom that will make it one of the major producers in Africa within the next 5 to 10 years. The boom has been stimulated by the opening of deep-water offshore blocks by the Government and by the development of new deep-water (1,000 to 3,000 meters) drilling and geophysical technologies by the petroleum industry. Between 1996 and mid-1999, more than 17 major new oilfields were discovered in offshore Angolan waters containing more than 6 billion barrels of recoverable oil resources. Chevron Corp. of the United States and Elf Aquitaine (Elf) of France were the major petroleum operators. In 1998, Cabinda Gulf Oil Company (CABGOC), a Chevron subsidiary, accounted for nearly 65% of the crude production from fields located offshore Cabinda. Crude oil production, which has more than quadrupled since 1980, averaged 735,000 barrels per day (bbl/d) in 1998. Chevron held a 39.2% share in the CABGOC joint venture with Sonangol (41%), Elf (10%), and Agip Petroli of Italy (9.8%). Chevron reported that its four new deep-water offshore oilfield discoveries in Block 14—Kuito (discovered April 1997), Landana (January 1998), Benguela (July 1998), and Belize (October 1998)—contained an estimated 3 billion barrels of potential petroleum reserves (Chevron Corp., 1999, Chevron's answer to low oil prices—West Africa, 1998 annual report, accessed December 12, 1999, at URL <http://www.chevron.com/finance/annual/download/download.html>). Discoveries by the Elf-led joint venture in Block 17 included Girassol (discovered in 1996 and containing reserves estimated to be approximately 1 billion barrels of petroleum), Dahlia (August 1997), Rosa (March 1998), and Lirio (September 1999) (Elf Aquitaine, September 3, 1998, Elf Aquitaine 1998 first half results show good resistance to drop in oil prices, press release, accessed December 27, 1999, at URL <http://www.elf.fr/us/actu/presse/98/cdpresema.htm>). The Dahlia and the Rosa finds are potentially larger than Girassol, but further appraisal of both discoveries was planned.

An Exxon-led joint venture announced the discovery in 1998 of four new deep-water oilfields in Block 15—Kissanje (February 1998), Marimbe (March 1998), Hungo (July 1998), and Dikanza (October 1998)—with combined total resources of more than 2 billion oil equivalent barrels (Exxon, 1999, Financial and operating review, Exploration and production—West and Central Africa, 1998 annual report, accessed December 22, 1999, at URL <http://www.exxon.mobil.com/news/companypubs/index.html>). Five offshore projects (four in Block 15 and the Girassol field, in which Exxon has a 20% interest) are targeted for start-up by 2005, with ultimate total gross new production of nearly 1 million barrels per day. Development has already begun in the Girassol field. Development planning is underway for Exxon-operated discoveries on Block 15 and additional resources on Block 17.

Total investment in new field development, a new oil refinery, and natural gas processing facilities, will exceed \$20 billion.

A more detailed discussion of recent developments in the Angolan oil industry is available through the U.S. Energy Information Administration website: Energy country analysis brief—Angola, accessible at URL <http://www.eia.doe.gov/emeu/cabs/angola.html>.

Reserves

Proven reserves of petroleum at yearend 1998 were reported to be 5.4 billion barrels and natural gas reserves to be 45.3 billion cubic meters (U.S. Energy Information Administration, June 1999, Country analysis brief—Angola, accessed October 9, 1999, at URL <http://www.eia.doe.gov/emeu/cabs/angola.html>). As discussed earlier, the proving up of discoveries made between 1997 and 1999 could easily double these reserves. Overall diamond reserves have been estimated to be between 40 million and 130 million carats (Republic of Angola, [1997], Angola's mining sector—Diamonds, business & economics, accessed November 12, 1999, at URL <http://www.angola.org/business/guide97/diamonds.html>).

Infrastructure

Angola's infrastructure suffered major deterioration during the civil war either through direct military action or from lack of maintenance. Before rebuilding can be done, the removal of land mines from strategic transportation routes remains a major priority. In 1997, the Government signed an agreement with Tor di Valle of Italy to restore the 1,350-km-long Benguela Railroad from the port city of Lobito to the border near the Copperbelt of Congo (Kinshasa). Historically, the Benguela line was the major and economically most efficient route for cobalt, copper, and manganese exports from the Copperbelt. Tor di Valle agreed to spend up to \$500 million to renovate the line in return for rights to harvest and export the eucalyptus from 37,000 ha of plantations along the rail line (John Fleming, May 26, 1997, Rebuilding begins on Angola's Benguela railway, Reuters, accessed May 27, 1997, at URL <http://biz.yahoo.com/finance/97/05/26/>). Renewed fighting in the area during 1998 and 1999 may well delay this renovation. In 1997, Odebrecht also contracted to construct the 329-megawatt powerplant at the Capanda Hydroelectric Project.

Outlook

Although offshore petroleum development and exports will dominate the economy of Angola for years to come and will provide a major impetus to rebuilding the war-torn economy and infrastructure, mineral development, especially of diamonds, will play a significant secondary role and will stimulate further economic growth on the local and regional levels. Geologic environments in Angola known to be favorable to economic mineralization have been off limits to exploration during the prolonged civil war. The return of mining investment and the application of modern exploration concepts and technology hold promise for additional mineral discovery opportunities in Angola. The attraction of needed new mineral investment, however, will be contingent on the end

of the civil war and the stabilization of the political environment.

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Major Source of Information

Ministry of Geology and Mines
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 Luanda, Angola
 Telephone: (244-2) 326-724
 Fax: (244-2) 321-655 or 322-569

TABLE 1
 ANGOLA: PRODUCTION OF MINERAL COMMODITIES 1/

Commodity	1994	1995 e/	1996 e/	1997 e/	1998 e/
Cement, hydraulic e/ thousand metric tons	240 r/	200 r/	270	301 2/	350 2/
Diamond 3/ 4/ thousand carats	1,400	2,900	2,500 2/	1,234 2/	2,764 2/
Gas, natural: e/					
Gross 5/ million cubic meters	5,600	5,210 2/	5,804 r/	5,804 r/	5,804 e/
Dry do.	560	560	566 r/	566 r/	566 e/
Granite thousand cubic meters	1,490 e/	1,500	1,500	1,500	1,500 e/
Marble do.	91	100	100	100	100 e/
Petroleum:					
Crude thousand 42-gallon barrels	196,370	232,800 2/	259,150 2/	262,800 2/	268,275 2/
Refinery products e/ 6/ do.	9,000	10,585 2/	11,000	11,700	12,000 e/
Salt metric tons	40,000	40,000	40,000	40,000	40,000

e/ Estimated. r/ Revised.

1/ Includes data available through September 1999.

2/ Reported figure.

3/ Does not include smuggled production.

4/ Production was approximately 90% gem grade and 10% industrial grade.

5/ Angola has no natural gas distribution system. Most gas was vented and flared.

6/ Includes asphalt and bitumen.

THE MINERAL INDUSTRY OF

BENIN

By Philip M. Mobbs

The production of mineral commodities, primarily cement and crude petroleum, represented a minor part of the economy of Benin. (See table 1.) Agriculture, commerce, and trade accounted for more than 80% of the country's gross domestic product (GDP), which was estimated to be about \$2.3 billion.¹ Real GDP growth was estimated to have declined to 4.4% in 1998 from 5.6% in 1997 (International Monetary Fund, December 22, 1998, Benin—Enhanced structural adjustment facility policy framework paper, 1998-2001, accessed May 27, 1998, at URL <http://www.imf.org/external/np/pfp/Benin/index.htm>).

Regulation of mineral extraction industries rests with the Ministère des Mines, de l'Energie, et de l'Hydraulique (Ministry). Act No. 83-003 of May 1983, which was the Benin Mining Code, Decree 89-296, implemented the Code's regulations, and Act No. 83-004 addressed fiscal policy affecting mineral development. The Government's recently adopted policy of actively encouraging foreign investment has been successful in the precious-metals sector. In 1998, the Ministry was tasked to promote construction materials, dimension stone, and peat and to strengthen the research capacities of the Office Béninois de Recherches Géologiques et Minières (OBGRM).

A new mining code was being considered by parliament. OBGRM assumed the mineral-development administration duties of the former Office Béninois des Mines (OBEMINES). The Government also created the Beninese Agency for the Environment and, on July 31, 1998, promulgated an environmental law. Associated environmental management implementing regulations were being assembled.

Benin was a country of almost 6 million people but had not the mining tradition that is found in other West African countries. Several illicit alluvial gold operations were underway, operated by non-Beninese West Africans. Formal gold exploration was concentrated in two areas in the Atacora gold zone in northwestern Benin—the Natitingou-Perma and the Djougou/Alédjo-Koura. Companies active in exploration included A.M.I. BENIN on a 772-square-kilometer (km²) concession, BHP World Minerals on concessions P6 and P7, Coronation International Mining Corp. of the United Kingdom on three exploration licences that covered 1,674 km², Hansa GeoMin Consult GmbH of Germany, Oracle, Sani Mines International Inc. of Canada on a 647-km² concession, and Texlon. In 1998, Resolute Ltd. of Australia secured an option to acquire 50% interest in all of BHP's West African concessions.

Benin's three cement companies, the Société des Ciments

d'Onigbolo and the clinker-grinders Cimentierie du Bénin S.A. (Scancem International, 48.7% interest) and Société des Ciments du Bénin, have a nameplate production capacity of about 875,000 metric tons per year (t/yr) sufficient to fulfill the domestic demand that was estimated at just more than 500,000 t/yr (Hargreaves and others, 1998). Severe power shortages affected Benin from March through June 1998 to the extent that the cement companies were authorized to import cement to cover production shortages.

In the petroleum sector, West Africa Resources, a subsidiary of Abacan Resource Corp. of Canada, and Addax Petroleum (Benin) Ltd, a subsidiary of Addax Petroleum Ltd. of Switzerland, acquired the deepwater offshore Block 4 in February 1997. Abacan and Addax also were partners on offshore Block 1, which surrounded the Government-operated Sèmè oilfield. In July 1997, Abacan acquired 100% participating interest in Blocks 1 and 4.

Petroleum production from Sèmè ceased in December 1998. The Government was considering alternatives for removal of the surface facilities and was investigating funding options, including a loan from the International Development Association, an affiliate of the World Bank.

Société Tarpon-Benin, owned by BBFI Benin Ltd., local investors, Profco Resources Ltd. of Canada, and Trans Coastal Industries Inc. of Canada, drilled the 2,761-meter Tarpon Ike No. 1 in 1997 on offshore Block 2. Well tests encountered only noneconomic returns. The wildcat well was plugged and abandoned, and in 1998, the companies agreed to relinquish the concession (Transatlantic Petroleum Corp., 1999). Archean Benin Energy S.A.R.L., a subsidiary of Archean Energy Ltd. of Canada, acquired a production-sharing contract for offshore Block 3 in 1997 and had existing seismic data reprocessed during 1998 (Yahoo, December 2, 1997, Archean Energy Ltd., accessed on December 4, 1997, at URL http://biz.yahoo.com/prnews/971202/archean_benin_partic_1.html). In 1998, Deminor, a subsidiary of Demindex of South Africa, and Thompson & Van Eyck were awarded the petroleum concession to onshore Block A (World Oil, 1998).

Benin, with a total installed electricity generating capacity of 54-megawatts (MW), traditionally imported much of its power needs, about 100 MW had been imported from the Akosombo hydroelectric plant in Ghana, and 60 MW, from the Nangbeto hydroelectric plant in Togo. In early 1998, drought curtailed regional electricity generating capability, resulting in Benin being limited to about 5 MW from Ghana and 15 MW from Togo.

In June 1998, Abacan Power (Benin) Ltd., a subsidiary of Abacan Resources; Enron Benin Power Ltd., a subsidiary of Enron Corp. of the United States; and the Government of Benin agreed to proceed with the construction of a 160-MW natural-gas-fired electricity generating plant in Cotonou. Enron was to

¹Where necessary, values have been converted from Communauté Financière Africaine francs (CFAf) to U.S. dollars at the average 1998 rate of CFAf588.6=US\$1.00.

build, own, and operate the plant and a 60-kilometer (km) natural gas pipeline to Abacan's offshore Aje natural gas discovery on OML 113 in Nigeria (formerly OPL 309). Proposed plant startup was December 1999.

Benin's transportation infrastructure consisted of 16,200 km of roads and the 438-km railroad from Cotonou to Parakou. To enhance the country's active reexport sector, the Government proposed a number of transportation sector reforms. The Government also hoped to increase the mining sector's contribution to national economic and social development, including job creation, increased diversity of exports, and as a source of foreign exchange and royalty revenue. It has proposed to establish a geologic information management system, to prepare a development strategy for the mining sector, and to revise the mining code.

Mineral-resource development opportunities identified by the Government included 10 million tons (Mt) of brick clay deposits at Zogbodomé, 5 Mt at Gbédji-Kotovi, and 1 Mt at Massi-Lomé; 1 Mt of kaolin at Adakpamé; feldspar; 506 Mt of iron at 46% to 52% iron with 13% to 15% silica at Loumbou-Loumbou and Madécali; more than 90 Mt of limestone usable for cement at Onigbolo and 17 Mt at Massé; about 33 million Mt of sandy limestone at Bakpodji; 6 Mt of marble at Idadjo; 12 Mt of peat near Cotonou; the 5.5 Mt of phosphate grading

25.2% P₂O₅ at Mékrou; silica sand; and a number of potential ornamental stone quarrying sites, including charnockite at Pototoumana, granite at Gobada and Parakou, granodiorite at Tebou, monzonite at Bétérou, and rhyolite at Pako. OBEMINES also had documented occurrences of columbium-tantalum, industrial diamond, gypsum, mica, nickel, rare earths, rutile, tungsten, and zirconium in Benin (Ministry of Energy, Mining, and Hydraulics, 1992; Ministère des Mines, de l'Energie, et de l'Hydraulique, written commun., 1997; Direction de la Promotion des Investissements, October 25, 1996, Note a l'attention des investisseurs potentiels, accessed May 25, 1999, at URL <http://planben.intnet.bj/pne//dpinote.htm>).

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TABLE 1
BENIN: ESTIMATED PRODUCTION OF MINERAL COMMODITIES 1/ 2/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997	1998
Cement, hydraulic	465,491 3/	578,827 3/	360,000 r/	450,000 r/	520,000
Gold kilograms	300	300	300	500	500
Petroleum, crude thousand 42-gallon barrels	884 3/	654 3/	600 r/	400 r/	200

r/ Revised.

1/ Includes data available through May 28, 1999.

2/ In addition to the commodities listed, a variety of industrial minerals and construction materials (clays, gypsum, sand and gravel, and stone) are produced; but information is inadequate to make reliable estimates of output.

3/ Reported figure.

THE MINERAL INDUSTRY OF

BOTSWANA

By Philip M. Mobbs

Botswana is Africa's largest and the world's second largest producer of diamond (Balazik, 1999). The mineral industry provided about 80% of the value of national exports and about 50% of Government revenue. The mining sector, mostly on the strength of diamond, accounted for about 33% of the gross domestic product (Commonwealth Africa Investment Almanac, 1998, Botswana, accessed on July 2, 1999, at URL http://www.tcol.co.uk/caia/part_3/countries/botswana/botinvest1.html). Nickel and copper production also played significant though smaller roles in the national economy.

Much of Botswana's economic growth since the 1970's could be attributed to the country's successful program of mineral exploration and development. In 1998, however, Botswana's economic growth stalled as the Asian economic crisis significantly reduced the international demand for diamond (Agence France-Presse, June 29, 1998, Botswana stockpiles diamonds in face of weak market, accessed August 21, 1998, at URL <http://www.afp.com/go/english/countries/page.phtml?id=botswana/light/980629190528.qd8pyuw6&name=Botswana>).

Trade

In 1998, diamond exports from Botswana were valued at \$1.4 billion compared with \$2.1 billion¹ in 1997. Asia had accounted for a significant proportion of international diamond sales. Because of the downturn in demand associated with the Asian economic crisis, the Central Selling Organisation of the United Kingdom, a subsidiary of De Beers Centenary AG, placed quota restrictions on diamond sales, forcing Botswana to stockpile a portion of its diamond production.

Government Policies and Programs

Under the National Development Plan 8 for the period from 1997 to 2003, the Government was formally seeking to diversify the national economy and reduce its dependence on diamond production. In 1998, the Mines and Minerals Act (Chapter 66:01) was amended. The Government encourages foreign investment, and there were no restrictions on reinvestment or repatriation of earnings and capital. The Ministry of Minerals, Energy, and Water Affairs has responsibility for the mining sector.

Structure of the Mineral Industry

The Government and Anglo American Corp. of South Africa Ltd. (AAC) were significant partners in Botswana's mineral

industry. De Beers, an AAC-affiliated company, owned one-half of Debswana Diamond Co. (Proprietary) Ltd. AAC had an equity interest in Botswana RST Ltd., which was the Government's partner in BCL Ltd., the nickel-copper-cobalt producer. AAC holdings also included substantial interests in Tati Nickel Mining Co. (Proprietary) Ltd. and Morupule Colliery (Proprietary) Ltd.

Besides AAC-associated Debswana and Botswana Ash (Proprietary) Ltd. operations, the Botswana mining industry consisted of a number of medium- and small-scale mines producing agate, aggregates, brickmaking clay, gold, and dimension stone.

Commodity Review

Metals

Cobalt, Copper, and Nickel.—BCL operated cobalt-copper-nickel mines and a smelter at Selebi-Phikwe, about 350 kilometers (km) northeast of the capital of Gaborone. In addition to treating its own ore, BCL toll-smelted concentrate and ore for Tati Nickel. Total smelter output of about 50,000 metric tons per year of cobalt-copper-nickel matte was shipped to Norway and Zimbabwe for refining. As nickel prices dropped during 1998, it was reported that BCL would require Government financial support in 1998 and 1999 (Metal Bulletin, 1998).

Exploration drilling by Tati Nickel confirmed the presence of additional copper and nickel resources. LionOre Mining International Ltd. of Australia reported that Tati Nickel's sulfide ore resources were estimated to be 50.9 million metric tons of ore grading 0.67% Ni and 0.35% Cu using a 0.3% cutoff grade (LionOre Mining International Ltd., September 16, 1998, Substantial increase in nickel resources—Botswana, accessed October 26, 1998, at URL <http://www2.cdn-news.com/scripts/ccn-release.pl?1998/09/16/0916028n>). In 1998, Tati Nickel installed a new fines circuit and completed a prefeasibility study for a new concentrator. With the increase of resources, Tati Nickel commenced a feasibility study on the installation of the new concentrator. Tati Nickel produced 6,427 metric tons (t) of nickel and 2,512 t of copper in 1998.

Cardia Mining NL of Australia and Mineral Holdings Botswana (Pty.) Ltd. were exploring on the Magogaphate base metals property. Fancamp Resources Ltd. of Canada was looking for joint-venture partners for its prospects in Botswana. On July 4, 1998, the Government's suspension of production order encompassing the Thakadu/Makala copper mining lease of Professional Property Projects (Pty.) Ltd., a subsidiary of Griffin Mining Ltd. of Bermuda (formerly European Mining Finance Ltd.) expired.

¹Where necessary, values have been converted from Botswana Pula (P) to U.S. dollars at the average rate of P4.217=US\$1.00 for 1998 and P3.635=US\$1.00 for 1997.

Gold.—Ashanti Goldfields Co. Ltd. of Ghana was exploring the Kraaipan gold project of Reunion Mining Botswana Ltd., a subsidiary of Reunion Mining Plc of the United Kingdom, and First Quantum Minerals Ltd. of Canada. Gallery Gold NL of Australia, formerly Gallery Resources NL, continued gold exploration and acquired an option on the Signal Hill prospect. Trillion Botswana (Proprietary) Ltd., a subsidiary of Trillion Resources Ltd. of Canada, held a number of prospecting licenses. Bushman Resources Inc. of Canada and Lion Mining Finance Ltd. of the United Kingdom terminated their respective options on Trillion's Kalahari gold prospect in early 1998.

Industrial Minerals

Diamond.—Debswana recovered diamond from the Jwaneng, the Letlhakane, and the Orapa Mines. Production was sold to the Central Selling Organisation. The \$440 million expansion of the Orapa diamond mine to a production capacity of about 12 million carats continued (African Mining, 1997).

A number of international mining companies held diamond licenses; these included the joint venture of AfriOre (Botswana) (Pty.) Ltd., a subsidiary of AfriOre (Mauritius) Ltd., and Billiton Plc of the United Kingdom; Gope Exploration Co., the joint venture of De Beers Prospecting Botswana (Pty.) Ltd. and the Botswana subsidiary of Falconbridge Ltd. of Canada; Fancamp Resources Ltd. of Canada; and Freewest Resources Canada Inc.

Auridiam Botswana (Proprietary) Ltd. (57.5%), a subsidiary of Auridiam Consolidated NL of Australia; Livre Holdings (Proprietary) Ltd., a subsidiary of Diamond Ventures NL of Australia (40%); and Nomathata Diamonds Inc. (2.5%) were exploring on the Mmashoro diamond property. Auridiam, M.I.T. Ventures Corp. of Canada, and Nomathata were exploring the Orapa licence. The Canadian joint venture of Contiki Resources Ltd., Layfield Resources Inc., and Southern Africa Minerals Corp. drilled the Molopo diamond license. Menora Resources Inc. of Canada continued exploration of the Tshane prospect. Redaurum Ltd. of Canada and Diamond Ventures Exploration (Pty.) Ltd., a subsidiary of Diamond Ventures NL, was exploring on the Orapa North diamond exploration lease.

Reunion and Ashton Mining Ltd. of Australia drilled the Ngami diamond prospect. Trillion Resources Ltd. of Canada was exploring on the Shashi diamond licence with Skeena Resources Ltd. and Nickelodeon Minerals Inc., both of Canada. TNK Resources Inc. of Canada and De Beers Prospecting Botswana (Pty.) Ltd. formed a joint venture to explore four areas on TNK's Gope area diamond license.

In 1998, Botswana Diamondfields Inc. of Canada discontinued work on the Deception Pan, the Mopipi, and the Tswapong area licences after discouraging results from sampling programs. Southern Africa Minerals drilled the Mosomane prospect, and relinquished most of the Kokong and the Mabuesehube diamond licences. Trillion and Winspear Resources Ltd. of Canada relinquished their Sowa Pan diamond license and Trillion allowed the Mmadinare gemstone lease to expire in 1998.

The Schacter & Namdar Group acquired 60% equity interest in the diamond cutting and polishing facility at Molepolole of Lazare Kaplan Botswana (Pty.) Ltd. for \$11.1 million (Yahoo,

March 2, 1998, Schacter & Namdar buys Kaplan factory in Botswana, accessed March 3, 1998, at URL http://biz.yahoo.com/bw/980302/schacter_a_1.html).

Infrastructure

Transportation facilities were good on the eastern fringe of the country, and in 1998, the 850-km Trans-Kalahari highway was opened from Gaborone, Botswana, to Gobabis, Namibia. Highways also connected landlocked Botswana with South Africa and Zimbabwe. A single-track railroad, operated by Botswana Railways, ran from north to south through the eastern part of the country connecting the South African and the Zimbabwean rail systems.

Outlook

The country's favorable geologic environment, mineral investment climate, political stability, and low tax rates should continue to make Botswana a target for foreign mineral investment. Declining international commodity prices in 1998 will add impetus to the Government's drive to diversify the national economy and to reduce its reliance on the diamond industry.

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Major Sources of Information

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TABLE 1
BOTSWANA: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity 2/	1994	1995	1996	1997	1998
Coal, bituminous	900,298	898,383	763,240	776,920	780,000 e/
Cobalt, smelter output, Co content of matte 3/ 4/	225	270	408	348	335
Copper:					
Mine output, Cu content of ore milled	27,500 e/	24,700 e/	25,275	22,840	25,043
Smelter output, Cu content of matte 3/ 4/	22,780	20,500	20,980	19,820 r/	22,124
Diamond 5/ thousand carats	15,550	16,802	17,388	20,111	19,772
Gemstones, semiprecious 6/ kilograms	67,000	20,000	35,000	54,000	54,000 e/
Gold 7/ do.	234	86	5	28	1
Nickel:					
Mine output, Ni content of ore milled	19,042	22,100 e/	21,910	19,860	21,700 e/
Smelter output, matte, gross weight 3/	51,488	49,931	58,910	50,570	56,732
Smelter output, Ni content of matte 4/	19,041	18,100	17,460	20,157 r/	22,851
Salt 8/	186,000	208,126	93,886	184,530	214,700
Sand, construction 9/ cubic meters	140,000	112,000	100,000	110,000 r/	90,000 e/
Soda ash, natural	174,000	201,657	119,137	199,990	195,500
Stone, crushed cubic meters	572,000	860,737	845,526	1,091,880	1,000,000 e/

e/ Estimated. r/ Revised.

1/ Table includes data available through August 27, 1999.

2/ In addition to commodities listed, clay for brick and tile, and silver were produced, but information was inadequate to reliably estimate output.

3/ Smelter product was granulated nickel-copper-cobalt matte.

4/ Included some product from direct smelting ore; that is, ore not reported as milled.

5/ Assumed to contain about 70% gem and near gem.

6/ Presumably, principally agate. Reported as sales.

7/ Reported as bullion; historically included silver estimated to be about 2%.

8/ From natural soda ash production.

9/ Additional production of sand and gravel from small local operations was periodically reported, but information was inadequate to estimate output.

TABLE 2
BOTSWANA: STRUCTURE OF THE MINERAL INDUSTRY IN 1998

(Metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
Clay 1/		Lobatse Clay Works (Proprietary) Ltd. (Botswana Development Corp. and Interkiln Corp. joint venture)	Lobatse, 70 kilometers south-southwest of Gaborone	50,000 e/
Do.		Makoro Brick and Tile (Proprietary) Ltd.	Makoro, 10 kilometers south of Palapye	20,000 e/
Coal		Morupule Colliery (Proprietary) Ltd. (Anglo American Corp. of South Africa Ltd. and related firms, 93.3%)	Morupule, 270 kilometers north-southwest of Gaborone	1,000,000
Cobalt 2/		BCL Ltd., (Government, 15%; Botswana RST Ltd., 85%)	Selebi-Phikwe, 350 kilometers northeast of Gaborone	500
Copper 2/		do.	do.	26,000
Copper ore		do.	do.	1,800,000
Do.		Tati Nickel Mining Co. (Proprietary) Ltd. (Lexan Trading Inc., 3/ 43%; Francistown Mining and Exploration Ltd., 4/ 42%; and Government, 15%)	Selkirk Mine, 23 kilometers east of Francistown and Phoenix Mine, near Francistown	1,560,000 5/
Diamond	thousand carats	Debswana Diamond Co. (Proprietary) Ltd. (Government, 50%; De Beers Centenary AG, 50%)	Jwaneng Mine, 115 kilometers west of Gaborone.	13,000
			Orapa Mine, 375 kilometers north of Gaborone.	7,000
			Lethakane Mine, 350 kilometers north of Gaborone.	900
Do.	do.	Tswapong Mining Co. (Proprietary) Ltd. (De Beers Prospecting Botswana Ltd., 85%; Government, 15%)	Tswapong Mine, 275 kilometers northeast of Gaborone.	3 e/ 6/
Gemstones, semiprecious	kilograms	Agate Botswana (Proprietary) Ltd.	Processing plant at Pilane, 45 kilometers north of Gaborone	60,000
Do.	do.	Masa Precious Stones (Proprietary) Ltd.	Bobonong, east of Selebi-Phikwe	4,000
Nickel 2/		BCL Ltd., (Government, 15%; Botswana RST Ltd., 85%)	Selebi-Phikwe, 350 kilometers northeast of Gaborone	23,000
Nickel ore		do.	do.	1,800,000
Do.		Tati Nickel Mining Co. (Pty.) Ltd. (Lexan Trading Inc., 3/ 43%; Francistown Mining and Exploration Ltd., 4/ 42%; and Government, 15%)	Phoenix Mine, near Francistown	1,500,000 7/
			Selkirk Mine, near Francistown	60,000 8/
Salt		Botswana Ash (Proprietary) Ltd. (Government, 50%; Anglo American Corp. of South Africa Ltd., 50%)	Sua Pan, 450 kilometers north of Gaborone	650,000
Soda ash		do.	do.	300,000

e/ Estimated.

1/ For brick and tiles.

2/ In nickel-copper-cobalt smelter matte.

3/ Subsidiary of Anglo American Corp. of South Africa Ltd.

4/ Subsidiary of LionOre Mining International Ltd. of Canada.

5/ Copper content estimated at 1.5%.

6/ Production began in September 1997.

7/ Phoenix Mine ships about 100,000 metric tons of concentrate grading about 5.5% nickel per year.

8/ Direct smelting ore grading about 2.6% nickel.

THE MINERAL INDUSTRY OF BURKINA FASO

By Philip M. Mobbs

Burkina Faso's economy was dominated by services and agriculture, which were estimated to account for about three-fourths of its gross domestic product (GDP) in 1998. In 1997, the last year for which data are available, GDP for this landlocked West African nation north of Ghana was estimated to be \$2.4 billion (World Bank, 1998). The minerals sector contribution to the GDP had declined to less than 1% in 1996 and continued to drop in 1997 and 1998. With the Poura gold mine on care and maintenance since early 1996, artisanal production had become the predominant source of gold, but gold output was expected to begin to rebound in 1999. Gold and manganese shipments had declined to less than 8% of total exports by 1997. On the import side, mineral fuels comprised about 11% of imports in 1997 (World Bank, 1998).

The Government encouraged the mining sector as part of its "Decade for Mining Development in Burkina Faso 1995-2005" Program. Law No. 023/97/II/AN of October 22, 1997, the new mining code, replaced law No. 14/93/ADP and law No. 06/95/ADP. Inaugurated in April 1998, the "Projet de Renforcement des Capacités Nationales du Secteur Minier et de Gestion de l'Environnement" is a 5-year Burkinabe mineral promotion and institutional support program. In October 1998, the Government hosted PROMIN'98, a regional mining promotion conference.

Most of the country is cut by belts of greenstone, the metamorphosed volcanosedimentary rocks that host most of the precious and other metallic mineralization in West Africa. The westernmost part of the country is underlain by Precambrian and Paleozoic sedimentary rocks in which a few small deposits of bauxite and marble are located. A small part of the southeastern corner of the country is underlain by sedimentary rocks that host phosphate deposits.

In 1997, Sahelian Goldfields Inc. of Canada acquired the option to acquire a 90% equity interest in the Poura gold operation, 200 kilometers (km) west of Ouagadougou, from the Société de Recherches et d'Exploitations Minières du Burkina, the state-owned mining company that formerly operated the Poura Mine. International Gold Resources Inc. of Canada, which was acquired by Ashanti Goldfields Co. Ltd. of Ghana, had held the option previously. In March 1998, Sahelian exercised the option and continued rehabilitation of the mine and mill funded by a grant of about \$13 million (ECU 11,000,000)¹ awarded to the Government by the European Development Fund's SYSMIN facility.

In September 1998, Sahelian submitted a positive feasibility study on reopening the mine to the Government. The Poura Mine was officially reopened on October 29, 1998, and was

treating 200 metric tons per day of ore by yearend. The Government retained an option to increase its 10% interest in the Poura operation to 20%. In addition to production at Poura, artisanal production came from about 200 operations scattered around the country.

In 1997, Société des Mines du Faso (Fasomine), a joint venture of Stremco S.A. of Burkina Faso (90%) and the Government (10%), acquired mining permits for the Guiro gold deposit. Griffin Mining Ltd. of Bermuda (formerly European Mining Finance Ltd.) held 51% equity interest in Stremco. Griffin reported that the Guiro deposits had resources of 338,000 metric tons of ore grading 11.3 grams per metric ton (g/t) of gold with a cutoff grade of 2 g/t (Canadian Corporate News, November 6, 1997, European Mining Finance Limited issues mining permits for Guiro Mine in Burkina Faso, accessed May 15, 1998, at URL <http://192.139.81.46/scripts/ccn-release.pl?1997/11/06/1106001n>). In 1998, the International Finance Corp. (IFC), a subsidiary of the World Bank, acquired 18% equity in Fasomine for \$500,000. The IFC also originated a \$1 million loan to develop the Guiro deposit as a small underground mine with an estimated 260 kilograms per year output (Griffin Mining Ltd., [undated], Projects—Guiro Project—Burkina Faso—Gold, accessed on September 11, 1999, at URL http://www.griffinmining.com/projects_guiro.htm). Stremco was prospecting on the rest of the Guiro exploration permit. Phelps Dodge Exploration Inc. of the United States had terminated its interest in an exploration joint venture on the prospect with Stremco in March 1997.

The gold rush continued in Burkina Faso. About 35 new exploration licenses, most in the southwest, were issued in 1998. Of the more than 100 mining companies in Burkina Faso, about 60% were local and 20% were Canadian. Several companies reduced or terminated their exploration efforts and were searching for additional funding or joint-venture partners. In 1998, relatively few concessions were relinquished despite the adverse funding situation most international gold mining companies encountered, but a number of concessions were technically in default because late surface tax payments or incomplete funding and work obligations on earn-in options.

Golden Eagle Mining Ltd. was earning participating interest in the Batie Sud and the Mdebedo permits of African Selection Mining Corp. of Canada. The joint venture of Ashanti Goldfields Co. Ltd. of Ghana and Echo Bay Mines Ltd. of Canada continued exploration of the Younga/Nangodi gold prospect. On the Madina-Foulbe and the Northwest Sabodala properties, AngloGold Ltd. of South Africa was earning 42.5% equity interest from Barrick Gold Corp. of Canada. Carlin Resources Corp. of Canada relinquished its interest in the Tenado gold concession.

Channel Resources Ltd. of Canada held 10 gold exploration permits. Three properties, the Bombore, the Naoube, and the

¹Where necessary, values have been converted from European Union Ecus to U.S. dollars at the average rate of Ecu0.80=US\$1.00 for 1996, Ecu0.88=US\$1.00 for 1997, and Ecu0.89=US\$1.00 for 1998.

Soubeiga, were part of an exploration joint venture with Solomon Resources Ltd. of Canada. Viceroy Resources Corp. of Canada was earning 60% equity interest in Channel's Bouroum property. Placer Dome Africa Ltd. was earning equity interest in six Channel concessions, including 57% in the Barao permit, 60% in the Bouroum North concession, 55.5% in the Madougou license, 49.2% in the Tounte permit, 60% in the Manapoule property, and 57% in the Somifa license. Channel reported resources of 35 million metric tons (Mt) at an average grade of 1.1 g/t gold, with a 0.5 g/t cutoff grade, on the Bombore concession; 12.4 Mt at a grade of 1.3 g/t gold on the Bouroum permit; and 1.5 Mt at a grade of 2.2 g/t gold on the Tounte permit (Channel Resources Ltd., 1998).

Cluff Mining Ltd. of the United Kingdom was exploring the Yako Arbole gold license. In February, Cluff entered a joint venture with Investissement Moto-Agricole Réalisation Burkina of Burkina Faso on the Kalsaka permit, north of Yako Arbole. Coronation International Mining Corp. of the United Kingdom held 10 gold exploration licenses covering the Doloma, the Dougouasso, the Dountéla, the Gueguere, the Gountela, the Lahrosso, the Loropéni, the Saramassi, and the Zono properties. On the Sebedougou concession, Coronation was exploring in joint venture with Orezone Resources Inc. of Canada.

BF GeoMin Mining Development Corp., a subsidiary of African GeoMine Mining Development Corp., a subsidiary of Etruscan Resources Inc. of Canada, was drilling on the Datambi permit. Emerging Africa Gold Inc. dropped its gold exploration properties in Burkina Faso. Greenhope Resources Inc. of Canada held an exploration permit for the Dassa property. Golden Knight Resources Inc. of Canada was active on the Monlouri and Seguenega gold concession. Sahelian acquired the option to earn 90% equity interest in the Larafella-Balago gold concession from Gold Fields Metals BV.

In 1998, the joint venture of High River Gold Mines Ltd. of Canada (61.5%), the Government (20%), and Resources Incanore Burkina (18.5%) commissioned a feasibility study on the development of a mine on the Taparko gold concession. High River indicated that Taparko had resources of 9.7 Mt grading 3.43 g/t gold (Delorme, 1998). Hyder Gold Inc. of Canada held the Kampti exploration permit. Kenor ASA of Norway was earning 72.5% equity interest in the Manga and the Nobere gold exploration permits. Kinbaouri Gold Corp. of Canada held the Oula, the Soukoura, and the Toutou concessions. A joint venture of Incanore Gold Mines Ltd. of Canada (75%) and Kinbaouri (25%) explored the PEM gold concession. Kinbaouri also was part of a joint venture acquiring 65% equity interest in the Dossi property.

Leo Shield Exploration NL of Australia held the Bougouriba and the Serakoro concessions. In 1998, Leo Shield acquired the Kabolo and the Kaikan gold exploration permits. Mutual

Resources Ltd. of Canada held the Seguenega permit. In 1997, Orezone Resources had acquired the Diapaga gold concession and interest in the IntiéDougou property from Geomaque Explorations Ltd. of Canada and also held the Ouairé Kérboulé license.

Oxford Resources Inc. of Canada was earning interest in the Bola-Niobaré and Kari gold properties. In November 1998, Avgold Ltd. of South Africa acquired the option to earn equity interest in the Kari and the Piela properties. The joint venture of Randgold Resources Ltd. of the United Kingdom and North Exploration (Overseas) Pty. Ltd. of Australia was examining the Sanmatenga license area. In 1998, Randgold also drilled on the Bissa prospect and acquired the Diarabokoko permit. The African exploration alliance of Australian companies, Resolute Ltd. and the Broken Hill Proprietary Co. Ltd., was evaluating the Belahoro, the Essakane, and the Loumana gold licenses. In 1998, Resolute also acquired the exploration license on the Nogbale property from WMC Ltd. of Australia. Local companies affiliated with SEMAFO Inc. of Canada held the Baho-Kari, the Bantole, the Bitou Nord, the Bogandé I, the Bogandé II, the Boulgou, the Kaba, the Kodyel, the Koumbia, the Lopal, the Mana, the Nayarara, the Oullo, Pilimpikou, the Tiefora, and the Tin Edia gold concessions.

In March 1998, InterStar Mining Group Inc. of Canada suspended operations at the Tambao manganese project in the northeastern corner of the country, and the property was placed under care and maintenance. InterStar reported that the Tambao ore had passed the various ore quality furnace trials of several ferroalloy facilities, but the cost of moving the manganese ore about 250 km to the nearest railhead and then on to ocean ports became prohibitive with the continued decline in the price of manganese ore. The Tambao deposit had more than 19 Mt of ore averaging 51.45% manganese (InterStar Mining Group Inc., 1999).

Billiton Plc of the United Kingdom explored the Perkoa zinc deposit and completed a prefeasibility study.

In August, granite quarrying and tile-processing operations at Burkina Granit in Ziniaré were inaugurated. Burkina Granit operated quarries at Kaya and Tampore and proposed to begin mining rock at the Béguéra, Kongoussi, and Pama quarries.

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TABLE 1
BURKINA FASO: ESTIMATED PRODUCTION OF MINERAL COMMODITIES 1/

(Thousand metric tons unless otherwise specified)

Commodity 2/	1994	1995	1996	1997	1998
Gold 3/ kilograms	1,637 r/ 4/	1,319 r/ 4/	1,063 r/ 4/	1,000 r/	1,100
Manganese, Mn content of ore	30	9	10	1	1
Pumice and related volcanic materials	11	11	11	10	10
Salt	7	7	7	5	5
Stone, marble	110	110	110	100	100

r/ Revised.

1/ Includes data available through September 2, 1999.

2/ In addition to the commodities listed, granite, phosphate, sand and gravel, and other construction material are produced, but information is inadequate to make reliable estimates of output.

3/ New reported series. Prior production data includes 2,458 kilograms in 1991, 2,302 kilograms in 1992, and 2,296 kilograms in 1993.

4/ Reported figure.

THE MINERAL INDUSTRY OF

BURUNDI

By George J. Coakley and Philip M. Mobbs

The landlocked, 27,830-square-kilometer Central African nation of Burundi is nestled between Rwanda, Tanzania, and the Democratic Republic of the Congo [Congo (Kinshasa)]. The World Bank estimated the population to be 6.6 million people. Subsistence agriculture accounted for much of Burundi's gross domestic product, which was estimated to be \$950 million in 1998 (World Bank, September 3, 1999, Burundi at a glance, accessed November 26, 1999, at URL <http://www.worldbank.org/data/countrydata/countrydata.html>). Civil unrest and guerrilla war hampered much of the economic activity in the country and were disincentives to foreign investment. Additionally, economic sanctions imposed on Burundi in 1996 by Congo (Kinshasa), Ethiopia, Kenya, Rwanda, Tanzania, Uganda, and Zambia remained in effect during 1998.

The Ministry of Energy and Mines is charged with the development and management of the nation's energy, mineral, and water resources.

Recently, Burundi has produced small quantities of columbium (niobium)-tantalite, gold, kaolin, and tin ore for export and limestone, peat, sand and gravel, and construction stone for domestic consumption, however; production statistics are unavailable.

The Comptoirs Miniers du Burundi reportedly mined columbium-tantalite in northern Burundi (Ruffini, 1998). The Burundi Mining Co. was assembling a 120-kilogram-per-year-of-gold trial mining project in northeast Burundi (Africa Energy & Mining, 1999). Andover Resources NL of Australia signed a protocol agreement to develop the Musongati, Nyabikere, and Waga nickel-cobalt laterite deposits in Burundi. The remote location of the deposits and long transportation routes have been a constraint on development. The Musongati area nickel

laterites were examined in detail by the United Nations in the late 1970's but warrant reexamination in light of the availability of newer, low-cost pressure acid leach hydrometallurgical technology. Peat was produced by the state-owned company Onatour as an institutional fuel and as a domestic cooking fuel substitute for firewood. The International Development Research Centre of Canada reported on a pilot project to produce a peat-based biomass charcoal in Burundi (International Development Research Centre, March 13, 1998, The partial carbonization of peat to make domestic fuel, accessed on May 5, 1998, at URL http://www.idrc.ca/nayudamma/peatfuel_39e.html).

Past surveys also have identified a phosphate-bearing carbonatite deposit at Matongo, rare-earth mineralization south of Bujumbura, a silica deposit near Ngozi, vanadium mineralization at Mukanda, and wolframite in the north and northeast (Ministry of Energy and Mines, 1991).

The outlook for the minerals industry was for little change, pending resolution of the political situation. Hydropower potential and abundance of water were advantages. Long export transportation corridors, poorly developed infrastructure, and long-standing ethnic hostilities were disadvantages.

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THE MINERAL INDUSTRY OF

CAMEROON

By Philip M. Mobbs

Crude oil production continued to be important to the economy of Cameroon, accounting for more than 40% of the country's foreign exchange earnings. Agriculture contributed about 45% of the 1997 gross domestic product (GDP) of \$9.1 billion,¹ the last year for which data are available. Minerals, primarily oil, accounted for 7% of Cameroon's GDP. For the 1996/1997 fiscal year, mineral-based commodities totaled about 48% of exports from Cameroon, with oil exports valued at \$763 million, aluminum exports worth \$95 million, and cement exports valued at \$16 million.

The legal system of Cameroon was modeled after French civil law. The mineral policy of Cameroon was based on the Mining Code, law 64-LF-3 of April 6, 1964, and Decree 64-DF-163 of May 26, 1964. Other pertinent legislation included the Mining Taxation Code, law 64-LF-13 of November 18, 1968, and the decrees regulating oil companies, law 82-20 of November 26, 1982, and law 95/13 of 1995.

The primary mining organization in Cameroon was the Government's Ministère de Mines, d'Eau et de l'Énergie (Ministry). The Government actively promoted investment in the mining sector, and foreign companies were usually involved in joint ventures with Cameroonian partners. Société Nationale des Hydrocarbures (SNH) was the state-owned company involved in hydrocarbon production and the Société Nationale de Raffinage (Sonara) was the state-owned company that managed the crude oil refinery. SNH held a 20% equity share, and other Government agencies owned an additional 46% of Sonara.

The aluminum smelter at Edéa was managed by Compagnie Camérounaise de l'Aluminium (Alucam), a joint venture of Pechiney of France (58%) and the Government (42%). Alucam processed alumina imported from Guinea. Diminished river flow resulting from a drought at the beginning of the year reduced electrical power availability, which constrained production at the Edéa smelter. Cameroon had installed generating capacity of 729 megawatts (MW), which was provided by three hydroelectric stations at Edéa, Lagdo, and Song-Loulou.

Small-scale artisanal operations had been recovering gold since the 1930's in the east and the north of Cameroon. In the northwest, near the Nigerian frontier, was the Mayo-Darlé tin resource. Cassiterite has been recovered from the area since 1933. Cimenteries du Cameroun operated a 350,000-metric-ton-per-year (t/yr)-capacity plant at Garoua and a 1-million-metric-ton-per-year clinker-grinding operation near the port of Douala. Clay and limestone were mined near Figuil for the cement industry that also consumed all pozzolan mined at Djoungo. Marble was quarried at Bidzar and Biou and was

finished at a 100-square-meter-per-day installation at Figuil. Silica sand was recovered along the coast for the glass industry.

Crude petroleum remained the most economically significant mineral commodity produced in Cameroon. The most prolific crude-oil-producing regions were the offshore Rio del Rey Basin and the adjacent Lokélé concession about 35 kilometers (km) offshore. The main petroleum operators in Cameroon were Elf Serepca, a subsidiary of Société Nationale Elf Aquitaine of France; Pecten Cameroon Co., a subsidiary of Shell Oil Co. of the United States; and Perenco plc of the United Kingdom.

In December 1997, the joint venture of CMS NOMECA Cameroon Ltd., a subsidiary of CMS Energy Corp. of the United States; GLOBEX Cameroon, LLC, a subsidiary of Global Exploration, Inc. of the United States; and SNH acquired production-sharing contracts on Blocks 1 and 6 in the Douala Basin (Alexander's Gas & Oil Connections, December 15, 1997, CMS Energy to explore in Cameroon, Company news—Africa, accessed May 20, 1999, at URL <http://www.gasandoil.com/goc/company/cna80967.html>). Ocelot Energy Inc. of Canada agreed to study the feasibility of developing the offshore Sanaga South offshore gasfields (Africa Energy & Mining, 1998b). Produced gas from the Sanaga South fields was projected to power a proposed 75- to 150-MW thermal electricity-generating station (Africa Energy & Mining, 1998c). National oil production had begun to rebound slightly in 1997 as Pecten drilled new wells and continued workover operations in the Rio del Rey basin. The International Finance Corp. had arranged the credit line for the new operations (Africa Energy & Mining, 1998a). Other companies exploring or producing in Cameroon included Mobil Corp. of the United States, the PetroFina S.A. of Belgium-Phillips Petroleum Corp. of the United States partnership, and Total S.A. of France (Oilwatch, undated, Camerun, accessed June 7, 1999, at URL <http://www.oilwatch.org/ec/espanol/tropicos/camerun.html>).

The International Court of Justice began hearings on the dispute between Cameroon and Nigeria concerning the Bakasi peninsula area.

Funding for the proposed 225,000-barrel-per-day pipeline from Chad's Doba basin to a terminal at Kribi, Cameroon, was being negotiated.

Cameroon had 49,210 km of road and a 1,003-km railroad that ran from Douala to Ngaoundéré.

Cameroon hosted a variety of mineral occurrences. The Government estimated that bauxite reserves of the Fongo Tongo, the Minim-Martap, and the Ngaoundal deposits totaled 1.1 billion metric tons grading 41.3% Al₂O₃. There were several iron deposits, including the 300-million-metric-ton (Mt) Les Mamelles deposit near Kribi containing 30% to 35% magnetite and the Mbalam deposit in southeast Cameroon near the border with Congo containing an estimated 220 Mt at 60%

¹Where necessary, values have been converted from Communauté Financière Africaine Francs (CFAf) to U.S. dollars at the average rate of CFAf535=US\$1.00.

iron (or 587 Mt at 30 to 40% iron). There were several nickel and cobalt occurrences, including the deposit east of Lomié estimated to contain 88 Mt at 0.22% to 0.24% Co and 95 Mt at 0.95% to 1% Ni (Ministère de Mines, d'l'Eau, et de l'Energie, written commun., undated; Ministère de Mines, d'l'Eau et de l'Energie, 1998, Ministère de Mines, d'l'Eau, et de l'Energie—Ressources Minière, accessed May 21, 1999, at URL <http://www.camnet.cm/investir/minmee/resmine.htm>; Ministère du Développement Industriel et Commercial, 1998, Produits du Cameroun, accessed May 21, 1999, at URL <http://www.camnet.cm/investir/mindic/produits.htm>).

The Société d'Exploitation du Rutile d'Akonolinga (S.E.R.A.K.) was formed in 1994 by the Bureau de Recherches Géologiques et Minières of France, Consolidated Rutile Ltd. of Australia, and the Government. Titanium minerals had been mined in Cameroon between 1935 and 1958, and S.E.R.A.K. was evaluating the country's remaining titanium resources. Rutile reserves between Akonolinga and Nanga-Eboko were estimated to be 3 Mt grading 92% to 95% TiO₂. According to Energy Information Agency estimates, crude oil reserves in Cameroon were about 400 million barrels, and natural gas reserves were estimated to be 110 billion cubic meters (Energy Information Agency, January 1999, Cameroon, Country Analysis Briefs, accessed May 21, 1999, at URL <http://www.eia.doe.gov/cabs/cameroon.html>). The Government also reported chromium, copper, dimension stone, gemstones, lead, phosphate, salt, and uranium occurrences (Ministry of Mines, Water, and Energy Resources, 1995; Ministry of Mines and Water and Energy, written commun., 1998; Ministère de Mines, d'l'Eau, et de l'Energie, written

commun., undated; Ministère de Mines, d'l'Eau, et de l'Energie, 1998, Ministère de Mines, d'l'Eau, et de l'Energie—Ressources Minière, accessed May 21, 1999, at URL <http://www.camnet.cm/investir/minmee/resmine.htm>; Ministère du Développement Industriel et Commercial, 1998, Produits du Cameroun, accessed May 21, 1999, at URL <http://www.camnet.cm/investir/mindic/produits.htm>)

The development of a diversified mineral industry in Cameroon was hampered by insufficient electrical power, the deterioration of the international minerals market during 1998, and the related diminished availability of project financing.

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- Ministry of Mines, Water, and Energy Resources, 1995, Mineral and Energy Potential of Cameroon: Yaoundé, Cameroon, 2 p.

Major Source of Information

Ministère des Mines, de l'Eau et de l'Energie
P.O. Box 955
Yaoundé, Cameroon
Telephone: (237) 22-34-00
Fax: (237) 22-61-77

TABLE 1
CAMEROON: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity 2/	1994	1995	1996	1997	1998 e/
Aluminum metal, primary	88,836	79,300	82,000 e/	90,000 r/	88,000
Cement, hydraulic e/	500,000 r/	300,000 r/	305,000 r/	350,000 r/	400,000
Gold, mine output, Au content kilograms	800	800	1,000 e/	1,000 e/	1,000
Petroleum:					
Crude thousand 42-gallon barrels	47,140	39,400	33,945	43,000 r/ e/	45,000
Refinery products e/ do.	8,000	9,000	9,200	9,200	10,000
Pozzolana e/	101,870 3/	90,000 r/	80,000 r/	100,000	105,000
Sand, silica e/	12,000	12,000	12,000	12,000	12,500
Stone: e/					
Limestone	57,000	57,000	50,000	50,000	50,000
Marble thousand cubic meters	550 r/	550 r/	560 r/	560 r/	580
Tin, ore and concentrate: e/					
Gross weight kilograms	3,000	2,000	1,000	1,000	1,000
Sn content do.	2,300	1,500	750	750	750

e/ Estimated. r/ Revised.

1/ Includes data available through June 4, 1999.

2/ In addition to the commodities listed, modest quantities of unlisted varieties of crude construction materials (clays, gravel, sand, and stone) presumably are produced, but output is not reported, and available information is inadequate to make estimates of output levels.

3/ Reported figure.

THE MINERAL INDUSTRY OF

CAPE VERDE

By Philip M. Mobbs

Mining's contribution to the economy of Cape Verde, an archipelago of 10 islands and 8 islets about 600 kilometers off the west coast of Africa, was minimal. The gross domestic product was estimated to be \$420 million¹ in 1997, the last year for which data were available. Most of the nation's mineral requirements were imported. About 7,000 metric tons per year of salt was produced on the island of Sal. Volcanic rock,

primarily pozzolana, was produced on Santo Antão. There also was intermittent production of marginally economic deposits of clay on São Vicente, Boa Vista, and Sal; gypsum on Maio; and limestone on Boa Vista, Sal, and Santo Antão. The Government strongly discouraged mining beach sand for construction material; beach sand mining was detrimental to the sea turtle nesting environment and the tourism industry.

For more extensive coverage of the mineral industry of Cape Verde, see the 1991 Minerals Yearbook, Volume III, Mineral Industries of Africa.

¹Where necessary, values has been converted from Cape Verde escudos (Esc) to U.S. dollars at the average rate of Esc93.19=US\$1.00 for 1997.

THE MINERAL INDUSTRY OF CENTRAL AFRICAN REPUBLIC

By Philip M. Mobbs

The Central African Republic was essentially an agrarian nation; agriculture accounted for about 54% of the nation's gross domestic product (GDP), estimated to be \$1 billion (World Bank, October 1, 1998, Central African Republic at a glance, accessed April 20, 1999, at URL <http://www.sangonet.com/FichiersRessources2/CAR-StatsBanqueM97.html>). The mining sector, dominated by the production and export of diamond, historically contributed about 4% of the country's GDP. In 1997, the latest year for which data are available, diamond exports of \$67 million accounted for 39% of the nation's export earnings, down from 48% in 1996 (World Bank, October 1, 1998, Central African Republic at a glance, accessed April 20, 1999, at URL <http://www.sangonet.com/FichiersRessources2/CAR-StatsBanqueM97.html>).

Mineral legislation was based on French mining law. The Mining Code, law No. 61/208, of April 11, 1961, was under administrative review. Hydrocarbon legislation was based on the Petroleum Code, Ordinance No. 73/016, of February 10, 1973, and the Investment Code of 1990 encouraged foreign investment through guarantees against nationalization, expropriation, and freedom from political or economic interference under certain circumstances. The country was a member of the Union Douanière et Economique de l'Afrique Centrale and a member of the Organization pour l'Harmonization du Droit des Affaires en Afrique (OHADA); OHADA was instituted to reconcile the commercial laws of the 16 member nations.

Gold was recovered by artisanal miners. In 1997, Aurafrique S.A.R.L., a subsidiary of Asquith Resources Inc. of Canada, acquired the prospecting and exploration permit for the Roandji gold concession from Howe Centrafrique S.A.R.L., the local subsidiary of United Reef Ltd. of Canada. United Reef retained a 3% net smelter returns royalty on the concession in the Bandas greenstone belt, approximately 320 kilometers east-northeast of Bangui. Aurafrique extensively explored the Agoudou-Manga area on the Roandji permit during 1997. The results from Agoudou-Manga were not encouraging, leading Aurafrique to begin the exploration of the Ndassima area in mid-1997. Additional geochemical surveys and percussion drilling on the property were done in 1998.

Artisanal diamond production supported a labor force estimated between 40,000 and 80,000. Diamond mining cooperatives were active. During 1997, Howe Centrafrique operated a 30-metric-ton-per-hour-capacity diamond-and-gold recovery plant at Mbala, on the Bamingui River for the joint venture of Trans Hex International Ltd. of Canada (47.1%), a subsidiary of the Trans Hex Group Ltd. of South Africa; United Reef (32.9%); and local nationals (20%). In 1997, Howe Centrafrique drilled and evaluated alluvial terraces along the Bamingui, the Bangoran, and the Goumbiri Rivers. On the basis of the drilling program's limited increase of diamond

reserves on the property and the political unrest in the country at the time, Trans Hex declined to contribute funds for additional operations (Trans Hex International Ltd., 1998). Despite the lack of Trans Hex support, Howe Centrafrique began mining at Mbala in May 1997. Decreasing diamond recovery in September and October led to the suspension of operations on October 15, 1997. Howe Centrafrique had produced more than 8,500 carats of diamond from the concession during exploration, pilot plant, and mining operations. Subsequent review of the operation by the joint-venture partners led to the decision in March 1998 to close the operation, to reclaim the mining area, and to sell the mining plant. The planned 1998 exploration of the Boungou concession by the Trans Hex-United Reef joint venture's Belafrique S.A.R.L. subsidiary was postponed.

Radisson Mining Resources Inc. of Canada had ceased funding its Central African Republic subsidiary, Radisson Centrafrique, by the beginning of 1997.

The lack of adequate transportation and industrial infrastructure, including the absence of a railway system, hindered the development of the nation's mineral industry. Security outside Bangui, the capital, was problematic. Shipments of diamond from the mines to Bangui have been robbed (Africa Energy & Mining, 1997). The military mutinies of 1996 and 1997 resulted in the insertion during April 1998 of an United Nation's (U.N.) peacekeeping force into Bangui. The U.N. forces were scheduled to leave the country in early 1999 (U.S. State Department, January 11, 1999, Central African Republic—Consular Information Sheet, accessed April 14, 1999, at URL http://travel.state.gov/central_african_republic.html).

Two greenstone belts, the Bandas and the Bogoin-Boali, outcrop in the Central African Republic and are the focal point of the nation's artisanal gold activity. Little of the country's 400,000-square-kilometer Precambrian terrane has been explored with modern techniques, leaving significant potential for the country to become an intriguing target for gold exploitation. Other mineral occurrences in the Central African Republic reported by the Direction Générale des Ressources Minérales included clay, copper, graphite, ilmenite, iron ore, lignite, limestone, manganese, monazite, rutile, tin, and uranium (Ministère des Ressources Énergétiques et Minérales, 1995).

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- Trans Hex International Ltd., 1998, 1998 annual report: Toronto, Trans Hex International Ltd., 28 p.

Major Source of Information

Ministère des Ressources Énergétiques et Minérales
Direction Générale des Ressources Minérales
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TABLE 1
CENTRAL AFRICAN REPUBLIC: ESTIMATED PRODUCTION OF MINERAL COMMODITIES 1/

(Carats unless otherwise specified)

Commodity 2/	1994	1995	1996	1997	1998
Diamond	531,940 3/ 4/	530,000	470,000	500,000	530,000
Gold kilograms	138 3/	97 r/ 3/	90	90	100

r/ Revised.

1/ Includes data available through April 16, 1999.

2/ In addition to the commodities listed, modest quantities of unlisted varieties of crude construction materials (clays, gravel, sand, and stone) presumably are produced, but output is not reported, and available information is inadequate to make estimates of output levels.

3/ Reported figure.

4/ About 75% of total diamond production in 1994 was reported as being of gem quality.

THE MINERAL INDUSTRY OF CONGO (BRAZZAVILLE)

By George J. Coakley

The Republic of Congo [Congo (Brazzaville)] is located in equatorial central Africa between the Democratic Republic of the Congo [Congo (Kinshasa)] and Gabon and has an area of 342,000 square kilometers. The area supported a population of about 2.7 million in 1998 with a gross domestic product per capita of \$1,500 based on purchasing power parity data. The civil war in 1997 did significant damage to the economy and land-based infrastructure. The renewed outbreak of fighting in December 1998 was a further setback to the country.

The economy of Congo (Brazzaville) was based largely on crude oil, with oil exports, valued at \$1.3 billion, accounting for 85% of total exports in 1997, the last year for which data were available. The country has major reserves of natural gas; however, all gas output is vented or flared owing to a lack of extraction and distribution infrastructure. Minor amounts of cement, gold, and lime were produced. The country has significant resources of magnesium that were being evaluated for development.

Investment was governed by the Investment Code of 1992 and Hydrocarbon Law 24/94 of August 23, 1994, which dictates the terms of production sharing agreements. The Hydrocarbon Law reduced taxes on crude oil production from 17.5% to 12%, with the state-owned Hydro-Congo participating in a 31% profit sharing on all production. Mining legislation is based on Decree No. 29-62 of June 1962, as amended by Decree No. 23/82 of July 7, 1982, and Decree No. 86/814 of June 11, 1986. In general, mining has been carried out by the state or through state-owned joint ventures. Prior to the breakout of the civil war in 1997, a new mining code was presented to the National Assembly and Senate for consideration, but apparently was not acted on. The new code would have opened up mining to private investment (Ngot Kongolo, 1997). In April 1998, the Congolese Government established a new national petroleum company, the Société Nationale des Pétroles du Congo (SNPC). SNPC is to market Congo's crude oil and to assume all upstream functions of the formerly state-owned Hydro-Congo. The process of privatizing Hydro-Congo's downstream operations has been underway since 1997.

The Ministry of Hydrocarbons and Mines has identified exploitable deposits of base metals (copper, lead, and zinc), diamond, gold, and platinum. Coastal deposits of phosphate and potash have yet to be exploited fully. Additionally, deposits of bentonite, granite, gypsum, kaolin, marble, and talc also have been found in the country. On May 27, 1997, the Government granted two exploration permits covering the Makola and the Youbi magnesium salt evaporite deposits in the Kouilou region to Congo Minerals, Inc., of Canada, which subsequently changed its name to Magnesium Alloy Corp. (MAC). A subsequent May 28, 1997, agreement called for MAC to expend a minimum of \$10 million on exploration and on preparation of a technical and bankable feasibility study within 4 years. The

new Government reratified exploration and development agreements with MAC in January 1998. MAC reported the successful completion of a 12-month technical feasibility study by Salzgitter Anlagenbau GmbH of Germany. The study proposed the solution mining of the large magnesium salt deposits, primarily carnallite (8.8% magnesium) and tachyhydrite (9.4% magnesium), and the use of a proven magnesium-extraction technology developed by the Russian National Aluminum and Magnesium Institute and the Ukrainian Titanium Institute. A solution-mining wellfield approximately 5 square kilometers would be sufficient to supply the magnesium extraction plant for 20 to 25 years. The \$514 million Kouilou project would produce 60,000 metric tons per year (t/yr) of primary magnesium and magnesium alloys, with a 2003 startup planned. As a byproduct of the magnesium operation salt, potash, and possible chlorine would also be produced. The energy intensive extraction process will require approximately 120 megawatts of electrical power and up to 120 million cubic meters of natural gas per year. MAC has an option to develop a hydroelectric dam on the Kouilou River, 75 kilometers (km) north of the proposed plant, or could draw on excess power from the Inga Dam in Congo (Kinshasa). Discussions were also underway on developing local gas reserves for the project (Magnesium Alloy Corp., June 21, 1999, Annual report of Magnesium Alloy Corp. for 1999, accessed December 22, 1999, at URL <http://www.magnesiumalloy.ca/finan/finan.htm>).

Several junior exploration companies were actively looking for gold or base metals during 1997 but, with the renewal of the civil war, were forced to pull back on operations by yearend 1998. AfriOre Limited of Canada announced a high-grade core resource estimate on the Yanga Koubanza lead-zinc deposit of 5.5 million metric tons grading 7.95% zinc, 6.97% lead, and 1.87% copper. Development plans for the project were delayed because of political uncertainties in the region (AfriOre Ltd., 1999, Projects—Congo—Yanga Koubanza, accessed January 21, 2000, at URL <http://www.afriore.com/>). SAMAX Gold Inc. of Canada, which was bought out by Ashanti Goldfields Corp. of Ghana during 1998, held a concessions in the Dimonika, the Kakamoeka, and the Ngongo districts within the Mayombe gold belt. During 1998, Samax discovered primary gold mineralization at its Mougongo prospect in an area worked only for alluvial gold in the past.

Cement was produced by one company, Société des Ciments du Congo, in which Scancem International of Norway held a minority interest. Nominal capacity was 250,000 t/yr with operating levels estimated at 40% for 1998 (International Cement Review, 1998).

The Elf Aquitaine Group of France was the major operator in the petroleum sector and had a 65% share in total crude production. Most of the national production of around 265,000

barrels per day (bbl/d) of oil was from offshore wells. Elf brought the major N’Kossa field into production in 1996, increasing output at N’Kossa to 67,000 bbl/d in 1998, lower than the planned production level of 100,000 bbl/d to 110,000 bbl/d. Italy’s Eni-Azienda Generali Italiana Petroli S.p.A. (Agip), which operated through its subsidiary Agip Recherches Congo, produced 67,000 bbl/d from its offshore operations in Congo (Brazzaville) during 1998. Elf continued development of the N’Kossa Sud field and of the Moho field in the Haute Mer area, in which Chevron Corp. of the United States held an interest. The U.S. Energy Information Agency reported total proven oil reserves of 1.5 billion barrels and natural gas reserves of about 90.6 billion cubic meters of natural gas reserves. A more detailed discussion of recent developments in the Congo (Brazzaville) oil industry is available through the U.S. Department of Energy, Energy Information Administration web site (U.S. Energy Information Agency, November 1999, Country analysis brief—Congo (Brazzaville), accessed December 12, 1999, at URL <http://eia.doe.gov/emeu/cabs/congo.html>).

Economic and political disruptions caused by the civil wars in 1997 and 1998 and the increased political risk associated with

investing in Congo (Brazzaville) will likely delay or discourage new petroleum and mining development in the country, although the primarily offshore oil industry is somewhat sheltered from the extensive damage to onshore infrastructure inflicted during the war.

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 Ngot Kongolo, J.C., 1997, Description sommaire du secteur minier Congolais: Multilateral Investment Guarantee Agency African Investment Symposium, 4th, June 3-5, 1997, Denver, Colorado., 6 p.

Major Source of Information

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TABLE 1
 CONGO (BRAZZAVILLE): PRODUCTION OF MINERAL COMMODITIES 1/

Commodity 2/	1994	1995	1996	1997	1998
Cement, hydraulic e/ thousand metric tons	87 r/ 3/	96 r/	50 r/	--	10
Gold, mine output, Au content e/ kilograms	12 3/	10 r/	10	10	10
Lime e/ metric tons	390 3/	390	390	390	390
Liquid petroleum gas e/ thousand 42-gallon barrels	--	--	3,650 e/	4,380 3/	4,380 3/
Petroleum, crude do.	67,525 r/	63,875	80,300 r/	98,550 3/	98,550 3/

e/ Estimated. r/ Revised.

1/ Includes data available through December 1999.

2/ Natural gas is also produced, but all of it is vented or flared.

3/ Reported figure.

THE MINERAL INDUSTRY OF CONGO (KINSHASA)

By George J. Coakley

The Democratic Republic of the Congo [Congo (Kinshasa)] is located in the heart of equatorial central Africa and has an area of 2,267,600 square kilometers (km²), which is about one-quarter that of the United States. The area supported a population of more than 50 million in 1998 with a gross domestic product (GDP) per capita of \$710 based on 1998 purchasing power parity data. Disruptions caused by civil wars in 1997 and 1998 and the uncertain investment policies of the new Government were a setback to the proposed new mineral development needed to revitalize the mineral economy of Congo (Kinshasa). Historically, the mining industry accounted for 25% of the GDP and about three-quarters of total export revenues. The near collapse of the economy, however, has made it difficult to sustain normal mining activities, and most foreign exploration activity came to halt by the end of 1998 following the outbreak of a new full-scale civil war in August 1998.

The state-owned La Générale des Carrières et des Mines (Gécamines), formerly the nation's major foreign currency export earner, continued its struggle to maintain copper production at 5% to 10% of capacity. The deterioration of the overall economy and the lack of reinvestment of Gécamines revenues in routine maintenance and capital development have contributed to this decline in the industrial mainstay of the economy.

Government Policies and Programs

Legislation has been passed relating to all aspects of the mineral industry. Article 10 of the Constitution states that the soil and subsoil belong to the state. Prospecting, exploration, and exploitation are regulated by Ordinance No. 81-013 of April 2, 1981, and required permits from the Ministry of Mines. During 1996 and 1997, the Government was successful in attracting a number of new foreign investors, particularly Canadian junior mining and exploration companies, for new grassroots exploration and joint ventures with Gécamines on the rehabilitation of known copper-cobalt, gold, manganese, and zinc mining properties. Parastatal operations targeted for privatization or joint-venture redevelopment included more than 20 copper-cobalt and zinc mines and processing facilities owned by Gécamines, the gold-tin producer Société Minière et Industrielle du Kivu (SOMINKI), the major diamond producer Société Minière de Bakwanga (MIBA), and the major gold producer Office des Mines d'Or de Kilo-Moto (Okimo). In 1997, more than 100 preliminary agreements for exclusive exploration zones ["zones exclusives de recherche" (ZER)] were been signed, and another 200 were pending. The projects held the potential for between \$2 billion and \$3 billion in new investments needed to revitalize the Congolese mining industry. Uncertainty, however, was raised among the international

mining and financial communities in late 1997 and January 1998, when the new Government canceled or questioned the legality of a number of exploration and mining agreements. Claiming that the companies "had been dragging their feet instead of starting work," the Government canceled mining exploration agreements with 12 companies (Metal Bulletin, 1998a; Business Day Online, January 27, 1998, Congo scraps 12 mining research deals, accessed January 27, 1998, at URL <http://www.bday.co.za/98/0127/news/n14.htm>). The Government also questioned the validity of agreements held by American Mineral Fields, Inc. (AMF), on its Kolwezi copper-cobalt tailings project and Ashanti Goldfields Company Ltd. of Ghana on the Okimo gold mine. During 1997, the new Government canceled a diamond marketing agreement between MIBA and De Beers Centenary AG and the management contract for the South African company operating Sizarail, the State-owned railroad.

Production and Trade

As estimated in table 1, production of most commodities, with the exception of refined cobalt, remained in decline during 1998. Diamond production estimates were more than 30% lower than those of 1997, but exact figures are uncertain owing to the high level of smuggling and undocumented artisanal production. The movement of illegally mined diamonds from Angola through Congo (Kinshasa) and other nearby countries to world markets adds to the difficulty in estimating real domestic production. Crude petroleum production remained constant at about 29,000 barrels per day (bbl/d). The more significant mineral commodities exported were, in order of value, diamond, cobalt, copper, crude oil, and gold. Historically, the main trading partners of Congo (Kinshasa) were Belgium, France, Germany, Japan, South Africa, and the United States. A program begun by Gécamines in 1994 to focus on high-unit-value cobalt production continued to give some returns as refined cobalt production increased by 60% to 4,490 metric tons (t) compared with that of 1997; production was valued at nearly \$223 million on the basis of the average market price for 1998. With the virtual collapse of the metal mining sector, diamond exports, chiefly from the Kasai Provinces, became the most important source of foreign exchange derived from the mineral sector. Trade data for 1997 (the latest available) indicated that officially exported diamonds accounted for \$717 million out of a total value of all goods exported of \$1.396 billion.

Structure of the Mineral Industry

The Government maintained at least part ownership and generally majority ownership of nearly all the productive and service sectors of the economy. Gécamines produced

essentially all the coal, cobalt, and copper either on its own account or with joint-venture partners. Gécamines also operated subsidiaries that produced cement and other materials required for its primary mineral interests. MIBA produced about 25% of industrial diamond production with the remainder coming from small artisanal operators. Components of Gécamines, Okimo, and SOMINKI were being offered for privatization or joint-venture operations with foreign partners.

Commodity Review

Metals

Copper and Cobalt.—Gécamines holdings in the Copperbelt in Shaba Province contained one of the greatest concentrations of high-grade copper and coproduct cobalt resources in the world. Since 1993, most mining operations have come to a standstill with total capacity utilization at less than 10% since then. Gécamines faced multiple crises in finance, production, and transportation. The company's poor condition was attributed to a combination of aging equipment; lack of domestic and international investment; lack of spare parts; shortages of fuel, lubricants, and sulfuric acid; problems with transporting ore and finished products; theft of finished products; debts owed to the state electrical company and Sizairail; flooding of open pit mines; and the inability to retain professional and other personnel because of disruptions caused by tribal conflicts and other factors.

To attract the capital needed to revitalize operations, Gécamines was using joint ventures with foreign investors and retaining up to 49% equity interest in these joint-venture arrangements, most of which ranged from 20% to 45%. In addition to treating stockpiled cobalt hydrates, Gécamines planned to start up production at three small-scale cobaltiferous mines at Kababankola, Kasombo, and Twilezembe and to rehabilitate metallurgical facilities at Kamoto and elsewhere. By the beginning of 1998, Gécamines had 23 cooperative projects, including development of the Tenke-Fungurume deposits, that it hoped would return production levels of copper to 400,000 t and cobalt to 25,000 t by 2000 (Swana, 1998); however, the outbreak of a new civil war has put the future of many of these projects in question.

In 1998, Gécamines entered into an agreement with OM Group, Inc. (OMG) of the United States, one of world's largest consumers of refined cobalt, and l'Enterprise Generale Malta Forrest SPRL (EGMF) to begin treating tailings from the Luiswishi copper-cobalt mine, which had been closed since 1962. Concentrates produced were shipped to the OMG Kokkola Chemical Plant in Finland. The Luiswishi project, which reopened in November 1997, was scheduled to produce 13,300 metric tons per year (t/yr) of copper and 2,800 t/yr of cobalt during a 13- to 15-year life of operations (Business Day Online, [November 11, 1997], Forrest reopens Luiswishi mine, accessed November 12, 1997, at URL <http://www.bday.co.za/97/1111/world/w17.htm>). OMG and EGMF continued construction work on a 5,000-t/yr cobalt smelter in Lubumbashi to produce cobalt-copper alloys from concentrate converter slags. The \$18 million slag treatment plant was scheduled to be completed by 2000 by Outokumpu Oy of Finland. The alloy product will be sent to the Kokkola refinery for final processing

(OM Group, Inc., 1999; OM Group, Inc., June 25, 1997, OM Group signs cooperation agreement to build smelter in Congo, press release, accessed July 8, 1997, at URL <http://www.omgi.com/pressrelease/062597.htm>).

In other cobalt-related developments, EGMF also operated the Kasomba 2 joint-venture project with Gécamines and Union Minière of Belgium (Mabiola, 1999). Ridgepointe Overseas Developments Ltd. of the British Virgin Islands produced cobalt from the Kababankola Mine near Likasi (Block, 1998). KGHM Polska Miedz, S.A., the Polish state-owned copper company, continued its operations at the Kimbe deposit (Metal Bulletin, 1998b).

In March 1998, First Quantum Minerals Ltd. of Canada signed two agreements with Gécamines for the retreatment of four large, high-grade copper-cobalt tailings dumps—the Kingamiambo and the Luilu tailings dumps located in the Kolwezi district and the Panda and the Shituru tailings dumps located at Likasi. Earlier in 1999, First Quantum had curtailed development activities owing to the political situation but was actively pursuing financing partners for what they described as economically robust projects once the political climate stabilizes. For the Kolwezi Copper/Cobalt Tailings Project, First Quantum reported measured resources at the Kingamiambo sulfide dump of 14.82 million metric tons (Mt) grading 1.13% copper and 0.26% cobalt. Measured resources were 13.78 Mt grading 1.98% copper and 0.35% cobalt at the Luilu hydrometallurgical tailings dumps. Because of its simpler metallurgical process for the recovery of metals, the Likasi Tailings Project would be developed before the Kolwezi Tailings Project. By financing the costs of the feasibility study and development of the project, First Quantum would earn a 51% interest in the Kolwezi Project with Gécamines holding 49%. These costs would be repayable from up to 85% of net income. At the Likasi Tailings Project, First Quantum evaluated four tailings dumps at Panda and Shituru. At the Panda 1 dump, measured resources were reported to be 2.32 Mt grading 1.52% copper and 0.23% cobalt; at the Panda 2 dump, 4.28 Mt grading 1.63% copper and 0.21% cobalt; at the Panda Laverie dump, 1.08 Mt grading 3.70% copper and 0.37% cobalt; and at the Shituru dump, 7.28 Mt grading 1.38% copper and 0.21% cobalt. An internal scoping study for Phase 1 of the Likasi Project proposed building a tailings reprocessing plant to treat 1 million metric tons per year (Mt/yr) of Panda 1, Panda 2, and Panda Laverie tailings that would yield 13,500 t/yr of copper cathode and 1,487 t/yr of cobalt (First Quantum Minerals Ltd., September 17, 1999, Property development, accessed October 8, 1999, at URL http://www.first-quantum.com/property_development.html).

The acquisition of 51% working interest in the Kambove and the Kakanda copper/cobalt tailings reprocessing projects from Gécamines by International Panorama Resources Corp. (IPR) of Canada in August 1996 was formally ratified by the new Government in June 1997; Gécamines was to receive a 1.5% royalty of the net profits after the capital payback period. Gécamines estimated the resource in tailings to be 61 Mt averaging 0.98% copper and 0.19% cobalt. Metallurgical tests by IPR suggested that the Kambove tailings were uneconomic owing to excessive acid consumption. During 1997, IPR spent around \$4 million on the project principally on a feasibility study of the Kakanda Project conducted by Bateman Minerals

& Industrial Ltd. of South Africa. The study outlined a “defined tailings reserve” of 18.4 Mt grading 1.22% copper and 0.15% cobalt and “measured minable open pit resource” of 11.3 Mt grading 3.14% copper and 0.19% cobalt. The study called for a capital cost of \$270 million to treat 3 Mt/yr of tailings for the first 7 years and then 2 Mt/yr of new mined material for an additional 7 years. The project would include an acid plant, an agitated vat leach stage, and a solvent extraction-electrowinning plant designed to produce 3,500 t/yr of cobalt cathodes and 54,000 t/yr of copper cathodes. Long-term commodity prices used for the feasibility study, which projected a 2-year capital payback, were \$11 per pound for cobalt and \$1 per pound for copper (International Panorama Resources Corp., October 23, 1997, Feasibility study confirms economic viability of copper/cobalt project in Democratic Republic of Congo, press release, accessed November 12, 1997, at URL <http://www.intlpanorama.com/news/oct23.html>). During 1998, the new Government ratified the agreement with IPR and Gécamines; the project was, however, essentially on hold by yearend.

AMF went through a tumultuous year during which Gécamines rescinded AMF’s rights to the Kolwezi Tailings Project, and AMF filed a \$3 billion lawsuit against the Anglo American Corp. of South Africa in a U.S. court for alleged interference with its agreement with Gécamines. Following internal management changes, AMF withdrew its lawsuit and reached an amicable agreement with Anglo American. In June 1998, AMF entered into a new 50-50 joint-venture agreement with Anglo American to develop the Kolwezi Tailings Project. The new joint venture was to be known as Congo Mineral Developments Ltd. (CMD). Anglo American funded CMD with an initial \$16 million to complete a bankable feasibility study of the Project and to secure its financing. CMD subsequently signed a Mining Convention with the Government and Gécamines for the transfer of ownership of the Project to a new company, KMT Sarl, to be held by CMD (60%) and by Gécamines (40%). The new Convention, which was subject to presidential ratification, provided for payments totaling \$130 million to be made to Gécamines in consideration of the transfer of the Kolwezi Tailings Project to KMT Sarl. The project had a provisionally estimated reserve of 112 Mt at average grades of 1.49% copper and 0.32% cobalt. Projected production was estimated to be 75,000 t/yr of copper and 7,500 t/yr of cobalt. The life of the project was estimated to be approximately 20 years. Capital expenditure was estimated on a prefeasibility basis at \$350 million with an implementation period of 2 years (America Mineral Fields, Inc., January 26, 1999, Kolwezi tailings convention signed, news release, accessed December 22, 1999, at URL http://www.am-min.com/99/jan26_99.htm; America Mineral Fields Inc., 1999, Democratic Republic of Congo—Mineral properties—Consolidated financial statements, notes to consolidated financial statements for 1998, accessed December 22, 1999, at URL <http://www.am-min.com/reports.html>).

In February 1998, the Government approved Anvil Mining NL of Australia’s Mining Convention for the right to explore and develop the Dikulushi copper-silver concession in southeastern Congo (Kinshasa) near the Zambian border west of Pweto and Lac Moero. In May 1998, Anvil announced the results of a prefeasibility study that showed the project to be

technically and financially viable. A two-phase project would produce 260,000 t/yr ore for first 4 years and 120,000 t/yr for the second 4 years at a capital cost of \$33 million. The project would concurrently produce ore from an underground mine at a rate of 120,000 t/yr and from an open pit mine at a rate of 140,000 t/yr on the basis of the previously reported resources. Life-of-mine head grades would average 8.9% copper and 289 grams per metric ton (g/t) silver. Production for the first 4 years would average 22,000 t of copper and 71,538 kilograms (kg) of silver. Flotation concentrate of 60% copper and 1,935 g/t silver would be shipped to the Zambian Copperbelt for smelting and refining (Anvil Mining NL, May 14, 1998, Dikulushi project prefeasibility study positive, Australian Stock Exchange announcement, accessed July 22, 1999, at URL <http://www.anvil.com.au/Asx/av1140598.htm>). Faced with the difficulty of obtaining financing for such a project given the political risks in the country, Anvil Mining was reconsidering development options to reduce capital costs by one-half that would include starting with the open pit mine only and buying used equipment. By yearend, the project was essentially on hold pending resolution of the political situation in Congo (Kinshasa). During 1998, First Quantum increased their holdings in Anvil Mining to 19%.

During 1998, Tenke Mining Corp. (TMC) of Canada (55%) in joint venture with Gécamines (45%) continued to examine the feasibility of developing the Tenke Fungurume copper-cobalt deposits located within two concessions totaling 1,437 km² in Katanga (Shaba) Province approximately 175 kilometers (km) northwest of the city of Lubumbashi. In December, TMC concluded an option agreement with BHP Copper of Australia whereby BHP would directly or indirectly acquire a 45% ownership interest in the Tenke Fungurume concession in return for providing certain development funding. A draft feasibility study was prepared for a project with a capital cost of around \$400 million. Initial production would include 100,000 t/yr of copper with expansion plans to more than double copper production at a later time. Cobalt capacity would be expanded to match sales contracts with up to 6,000 t/yr planned in the first 4 years and would increase to 13,000 t/yr of cobalt in future expansions. Preliminary plans call for a mine production of 85 Mt/yr of oxide ore at an average acid-soluble grade of 3.19% copper and 0.29% cobalt during an initial 15-year life. The Tenke Fungurume copper-cobalt concessions were estimated to contain a resource base of more than 500 Mt grading 3.5% copper and 0.27% cobalt. Further extensive reserves are available, and production can be progressively expanded. Further open pit oxide reserves will be proven up, and the extensive sulfide resource underlying the oxide zone is known to extend well below 500 meters in the areas tested and over a strike length of up to 100 km. Much of the sulfide is accessible by open pit methods (Tenke Mining Corp., 1999, Tenke Fungurume, accessed November 12, 1999, at URL <http://www.tenke.com>). On February 23, 1999, TMC declared force majeure in accordance with its Tenke Fungurume agreements with Gécamines and the Government because “the continuing military turmoil and political events in the DRC, which commenced on or around 2 August 1998, materially affected the Company’s ability to carry out the Tenke Fungurume Project. These events entail and continue to entail material changes as to the conditions of development and

operation of the Project (including power supply, transportation and construction resources) and thereby undermine the existing draft feasibility study and make it presently impossible to produce a final feasibility study. Accordingly, notice was given of Force Majeure in accordance with the Company's agreements and this has the effect of adjusting all time periods and dates under these agreements by taking into account the extension and delay arising out of these events of Force Majeure. This includes the obligation to complete the feasibility study and the payment of the transfer bonuses. The option agreement with BHP Copper is unaffected by this declaration" (Tenke Mining Corp., February 23 1999, Force majeure declared, news release, accessed February 26, 1999, at URL <http://www.tenke.com>).

Gold.—Société Aurifère du Kivu et du Maniema S.A.R.L. (SAKIMA), which is controlled by Banro Resource Corp. of Canada (93%) and the Government (7%) was established in January 1997 to operate the former SOMINKI gold, tantalum, and tin mines and other land holdings in the region. The old SOMINKI holdings included 10 mining permits and 47 mining concessions covering 10,271 km². Gold holdings southwest of Bukavu in Kivu Province included the Kamituga-Mobale underground gold mines, which were forced to close during the 1997 civil war, and the Lugushwa, the Namoya, and the Twanziga properties. By the presidential decrees of July 29, 1998, however, the Government, without prior warning or consultation with Banro, dissolved SAKIMA through which Banro held its mineral properties and carried on business in Congo (Kinshasa), terminated the company's Mining Convention relating to the company's mineral properties, created Société Minière du Congo S.A.R.L. (Somico), and appointed certain Congolese Government nominees as officers of Somico. The action put Banro's ownership of certain SAKIMA mining concessions and related assets in question (Banro Resource Corp, March 19, 1999, Uncertainty regarding interest in the Democratic Republic of Congo—Consolidated financial statements, December 31, 1998 and 1997—Notes to consolidated financial statements, accessed April 1, 1999, at URL <http://www.banro.com/123198.html>). Because military hostilities began in August within the Provinces of Maniema, North Kivu, and South Kivu in eastern Congo (Kinshasa), Banro was forced to evacuate all employees from the area. In accord with provisions of its Mining Convention with the Government, Banro filed a suit for \$1 billion in compensation claims with the International Center for the Settlement of Investment Disputes (ICSID); it was accepted for arbitration in October 1998 (Banro Resource Corp, October 29, 1998, Arbitration of Banro \$1 billion claim to proceed, news release, accessed April 1, 1999, at URL, <http://www.banro.com/releases/10-29-98.html>). The first Arbitral Tribunal was scheduled to be convened by the ICSID in Washington, DC, on May 7, 1999.

During 1998, Barrick Gold Corp. of Canada was joined by AngloGold Ltd. of South Africa in evaluating a 57,000-km² exploration concession near the Kilo-Moto goldfields in the Bunia area of northern Congo (Kinshasa), adjoining Sudan to the north and Uganda to the east. Initial geochemical and drilling efforts identified a mineralized open pit deposit near the town of Doko that contained approximately 40,400 kg

of refractory gold. Work was stopped in late August when the onset of civil unrest forced the companies to withdraw personnel, data, and equipment to a safer location (AngloGold Ltd. 1999).

During 1998, Ashanti resolved its ownership dispute with the Government and the previous title holder and took over operation of the 2,000-km² Kilo-Moto Mining International S.A.R.L. (Kimin) concession in the rebel-controlled Eastern Province.

Manganese.—Cluff Mining PLC of the United Kingdom signed a joint-venture agreement with the Government and the state-owned Enterprise Minière de Kisenge-Manganese to revive the Kisenge manganese ore mine and to erect a 60,000-t/yr ferromanganese or silicomanganese plant. The Kisenge Mine, which was formerly owned by Belgium's BCK Manganese Company, was nationalized in 1974 and has been completely dormant since about 1990. At its peak, the mine produced 300,000 t/yr of high-grade manganese ore from three open pits. Remaining proven reserves have been estimated to be 7 Mt, and there was a 600,000 t stockpile of washed and screened ore (Mbendi Information Services, July 1, 1999, Democratic Republic of Congo—Mining industry—Other minerals, accessed December 22, 1999, at URL <http://mbendi.co.za/indy/ming/mingzr.htm>).

Zinc.—An August 1996 framework agreement between Gécamines and AMF to prepare a feasibility study on the reopening of the Kipushi zinc-copper mine, rehabilitating the concentrator, and reprocessing the existing tailings expired in October 1998. AMF was then informed by Gécamines that the terms of the option agreement would remain in effect for the foreseeable future (America Mineral Fields Inc., 1999, Annual report of American Mineral Fields Inc for 1998, accessed December 22, 1999, at URL <http://www.am-min.com/reports.html>). Under the original agreement, AMF could acquire a 51% equity interest if a successful feasibility study led to another agreement with Gécamines to rehabilitate the mine and smelter, which had closed in 1993. Preliminary estimates by AMF projected a cost of \$30 million to renovate the mine and mill, which produced 143,000 t/yr of zinc and 43,000 t/yr of copper during its peak production year of 1988. The Kipushi Mine was also a major source of germanium. A feasibility study of building a smelter to produce 200,000 t/yr of zinc, 30,000 t/yr of copper, and 400,000 t/yr of sulfuric acid was underway. Capital costs for the smelter were projected to be about \$350 million. Watts, Griffiths and McQuat of Canada, an AMF consultant, confirmed Gécamines' earlier estimates of remaining measured resources of 9.9 Mt at 2.51% copper, 0.47% lead, and 9.96% zinc. Combined measured and indicated mineral resources were 20.6 Mt grading 2.27% copper, 0.47% lead, and 15.18% zinc. After 10% dilution, minable proved and probable reserves, were given as 22.6 Mt grading 2.06% copper and 13.81% zinc. An additional indicated mineral resource of approximately 16 million cubic meters of Kipushi tailings graded an average 0.36% copper, 1.62% lead, and 2.25% zinc (American Mineral Fields Inc., 1996, The Kipushi project, Zaire, accessed September 22, 1997, at URL <http://am-min.com/96/kipushi/kproj.html>).

Industrial Minerals

MIBA accounted for about one-quarter of the total national production of diamonds from mining operations in Mbuji Mayi in Kasai Province. MIBA was owned by the Government (80%) and by the Sibeka Group (20%), which was owned by Union Minière of Belgium (79%) and De Beers Centenary AG (De Beers) (20%). MIBA produced 6.4 million carats per year of low-value, near-gem-quality stones in 1998, an increase of 18% from that of 1997. In an effort to exercise more control over the diamond industry, the Government established a new department, referred to as SASMIP, to buy precious minerals, and to ban the use of U.S. dollars in diamond sales and the travel of foreign buyers to the diamond areas. The new policy was resisted by the artisanal diamond operators and official exports dropped sharply (Mabiola, 1999).

Mineral Fuels

Zaire Gulf Oil Co., which was owned by Chevron Corporation of the United States (50%), Teikoku Oil Co. Ltd. of Japan (32.3%), and Unocal Corporation of the United States (17.7%), produced approximately 75% of the nation's 29,000 bbl/d of crude petroleum from around 35 offshore wells. The only domestic oil refinery, at Muanda, had a rated capacity of 17,000 bbl/d. Chevron, which operated a 1010-km² offshore concession, produced crude oil from eight offshore fields; production averaged 20,000 bbl/d day in 1998. Work by Chevron concentrated on development drilling, not exploratory drilling. The company announced that approximately 95% of its concession area was covered with three-dimensional seismic data. Processing of the new seismic data was completed in 1998, and interpretation was scheduled to begin in 1999 (Chevron Corp., 1999, Democratic Republic of Congo, Worldwide Upstream supplement to 1998 annual report, accessed December 22, 1999, at URL <http://www.chevron.com/finance/annual-98-supplement/p10.html>).

Reserves

Major mineral resources were generally considered to be sufficient for many years of production with known copper ore grades running two to eight times the grade of typical copper ore mined in North America and South America. Reserve data on copper, cobalt, gold, and zinc, however, have not been updated for several years and must be reevaluated in light of current (1998-99) economic conditions in Congo (Kinshasa) and the deterioration of Gécamines' mines and other facilities. At yearend 1997, reserves of oil and gas were 187 million barrels of oil and 1.4 billion cubic meters, respectively (PennWell Publishing Co., 1998). As of 1996, estimated recoverable coal reserves were 88 Mt (U.S. Energy Information Administration, August 1998, Southern African Development Community, Table 5. SADC energy overview—Coal, accessed July 8, 1999, at URL <http://www.eia.doe.gov/emeu/cabs/sadc.html>).

Infrastructure

Congo (Kinshasa) is an essentially landlocked country, with

only a small coastal area on the Atlantic Ocean. The main port of Matadi, with a 160-km river approach, has had difficulty operating at its 2-Mt/yr cargo capacity. Waterfalls below the capital of Kinshasa make the Congo River unnavigable to the sea and limit the significance of the world's second largest river as a significant export route, although it is a key inland commercial route.

A combination of air, railroad, road, and river boat transport was used to move equipment, food, and other supplies into the mining and mineral-processing regions and for exporting ores, concentrates, and finished mineral products. Even prior to the breakout of civil war, much of this transport network was in varying degrees of disrepair. Locomotive and rolling stock shortages were also a problem. The Sizarail line was a critical logistical support link for the diamond industry between the Zambian border and Mbuji Maya.

The major companies involved in transportation were Government owned. Small private trucking and river boat companies provided limited local service. Historically, mineral products were sometimes shipped from the Copperbelt west on the Voie Nationale, a difficult road-rail-water route and the only transport route entirely within the country to Matadi, through Zambia on the Tazara railroad to the port of Dar es Salaam in Tanzania; and through Zambia to southern rail lines that lead to bulk-loading export ports in South Africa. Copper shipments could take 45 days to get from the plant to the dock, either south via Zambia and Zimbabwe or eastward along the Tazara railroad via Zambia and Tanzania. Owing to rail and river transport problems, most cobalt and copper wirebar products were shipped via truck convoy to the port of Durban in South Africa. High-value cobalt, diamonds, and gold are commonly flown out of the country.

Shaba Province, the site of most of the country's mining activity, historically consumed almost 50% of the nation's generated electrical power. A portion of the electricity used in the Shaba region was delivered by the 1,800-km-long, 560-megawatt Inga-Shaba transmission line, which runs from the Inga Dam on the Congo River south of Kinshasa to the Copperbelt city of Kolwezi in Shaba Province. Nevertheless, the tremendous hydroelectric potential of the Congo River remained largely untapped. For energy requirements at its mine and metallurgical operations, Gécamines was dependent on imported coke and refined petroleum products.

Outlook

The short-term economic prospects for Congo (Kinshasa) are poor and further threatened by civil wars, turnovers of Governments, and refugee problems and ethnic conflicts in the eastern provinces bordering Rwanda and Uganda. The decline of copper and cobalt production during the 1990's has led to the deterioration of the country's most important company, Gécamines. Despite almost insurmountable operating difficulties, Gécamines continued to operate, albeit at limited capacity. Changing Government policies promoting privatization of the state-run mining sector to attract new foreign capital and technical expertise holds some hope for the future but requires stronger guarantees of property title and investment security by the Government. Because of its size and wealth of resources, the long-term potential of Congo

(Kinshasa) is more promising, and the country could return to world markets as an important supplier of copper, cobalt, diamond, and zinc. The future prospects for economic development of Congo (Kinshasa) depend on its ability to achieve political and economic stability, to mobilize its resources, to control Government spending, and to attract new foreign investment.

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TABLE 1
CONGO (KINSHASA): PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997	1998 e/
METALS					
Cobalt:					
Mine output, Co content	826	1,647	2,000 e/	3,500 e/	1,500
Metal, Co content:					
Refinery (salable products)	2,439 r/	3,422 r/	3,540 r/	3,700 e/	3,600
White alloy, matte	945	546	2,300 e/	341 e/	344
Total	3,384	3,968	5,840	4,041 r/ 2/	3,944 2/
Columbium and tantalum:					
Columbite-tantalite concentrate:					
Gross weight kilograms	4,120	--	--	--	--
Nb content e/ do.	1,000	--	--	--	--
Ta content e/ do.	1,000	--	--	--	--
Copper: 3/					
Mine output:					
By concentration or cementation	7,200	6,800	6,200	--	--
Leaching (electrowon)	22,800	22,600	43,800 r/	39,651 r/ 2/	34,994 2/
Total	30,000	29,400	50,000 r/	39,651 r/ 2/	34,944 2/
Metal:					
Smelter, primary:					
Electrowon (low grade)	22,800	22,600	43,800 r/	40,000	35,000
Other	7,200	6,200	6,000	--	--
Total	30,000	28,800	49,800 r/	40,000	35,000
Refinery, primary:					
Electrowon	--	--	--	--	--
Other	29,000	33,000	42,200 r/	40,000	35,000
Total	29,000	33,000	42,200 r/	40,000	35,000
Gold 4/ kilograms	780	1,180	1,252	394	134
Silver e/ do.	900	900	500	500	500
Tin:					
Mine output, Sn content	100 r/	-- r/	-- r/	--	--
Smelter, primary e/	50	--	--	--	--
Zinc:					
Mine output, Zn content	500 r/	4,500 r/	3,200 r/	1,686 r/ 2/	1,234 2/
INDUSTRIAL MINERALS					
Cement, hydraulic	166,000 e/	235,000 e/	240,800 r/	124,900 r/	100,000
Diamond: e/					
Gem thousand carats	3,000	4,000	3,000	3,300 e/	4,500
Industrial do.	13,300	13,000	17,600	18,900 e/	20,000
Total do.	16,300	17,000	20,600	21,000 r/ 2/	24,500 2/
Lime e/	50,000	50,000	50,000	50,000	50,000
Stone, crushed e/	200,000	200,000	200,000	200,000	200,000
MINERAL FUELS AND RELATED MATERIALS					
Coal, bituminous e/	11,000 4/	10,000	10,000	5,000 e/	5,000
Petroleum:					
Crude thousand 42-gallon barrels	9,125	10,220	10,000 e/	10,950 e/	10,950
Refinery products:					
Liquefied petroleum gas e/ do.	5	5	1	1	1
Gasoline do.	365	365 e/	89 e/	89 e/	89
Kerosene and jet fuel do.	545	545 e/	135 e/	135 e/	135
Distillate fuel oil do.	365	365 e/	90 e/	90 e/	90
Residual fuel oil do.	1,095	1,095 e/	280 e/	280 e/	280
Refinery fuel and losses 5/ do.	545	545	135	135	135
Total do.	2,920	2,920 e/	730 e/	730 e/	730

e/ Estimated. r/ Revised.

1/ Table includes data available through December 1999.

2/ Reported figure.

3/ Terms are used as defined by the International Copper Study Group.

4/ Reported by Banc Centrale du Congo. Gold Field Mineral Services estimates production from all sources to be 5,000 to 10,000 kilograms.

5/ Includes "Other."

THE MINERAL INDUSTRY OF CÔTE D'IVOIRE

By Philip M. Mobbs

The mineral industry of Côte d'Ivoire was an increasing significant input in calculating the nation's primarily agrarian-based gross domestic product. Since 1995, the country's offshore hydrocarbon production operations have become an important domestic source of energy. Côte d'Ivoire's gold-bearing Birimian greenstones have attracted the interest of a number of international exploration companies.

The Government promoted the responsible development of the country's mineral resources and had documented numerous mineral deposits, including bauxite, brick clay, ilmenite, iron, manganese, nickel, glass sand, dimension stone, tantalite, and tin (Ministère des Ressources Minières et Pétrolières, 1996). The new Mining Code, loi No. 95-553, and associated regulations contained in Décret No. 96-634 replaced 1964 Mining Code. Petroleum activity was covered by the 1996 Hydrocarbon Code. Mineral development policy was administered by the Ministère des Ressources Minières et Pétrolières. The national mining company, Société pour le Développement Minier (SODEMI), promoted and participated in the exploration and development of nonhydrocarbon mineral resources. La Société Nationale d'Opérations Pétrolières de la Côte d'Ivoire (Petroci) was the Government-owned company charged with managing the national hydrocarbons sector. The state received a 10% carried interest in all mineral operations.

The Société des Mines d'Ity (SMI), a joint venture of LaSource Group of France (51%) and SODEMI (49%), operated the open pit Ity gold mine, about 500 kilometers (km) northeast of Abidjan. LaSource increased its equity interest in SMI from 40% in 1998 and proposed to double gold production to about 2 metric tons per year (Africa Energy & Mining, 1998). The Société des Mines d'Afema (Somiaf), a joint venture of Eden Roc Mineral Corp. of Canada (68%) and SODEMI (32%), mined out the concession's known oxide ore and closed the open pit Afema Mine in 1998. Somiaf began rehabilitation of the site. Anglo American Corp. of South Africa acquired an option on 60% equity interest in Eden Roc's exploration and production licenses (Africa Energy & Mining, 1998; Northern Miner, 1998).

In mid-1998, Compagnie Minière d'Afrique, a subsidiary of LaSource, began construction of a gold mine on the Angovia property. Early in 1999, the La source joint venture was restructured. Joint-venture partner Normandy Mines Ltd. of Australia retained the Ity Mine and exploration permits in Côte d'Ivoire and partner Bureau de Recherches Géologiques et Minières (BRGM) of France retained the \$13.3 million Angovia project (Mining Journal, 1998; Normandy Mining Ltd., 1999).

Occidental Gold (Ivory Coast) SARL, a joint venture of Leo Shield Exploration NL of Australia and Société Minière Côte d'Ivoire, formed an exploration alliance with Randgold Resources Ltd. of the United Kingdom on the Tengrela East and the Tengrela South gold permits. Resolute Ltd. of Australia

acquired the concessions of WMC Ltd. of Australia (formerly Western Mining Corp.). In June 1998, Resolute entered into an exploration alliance with Broken Hill Proprietary Co. Ltd. of Australia. Other companies maintaining gold exploration permits in Côte d'Ivoire included Africwest Gold of Australia and partners on permit recherche (PR) 113 and 114; Anmercusa Exploration Ltd., a subsidiary of Anglo American, on the Hana Lobo permit; BRGM on PR 43; Cluff Mining Ltd. of the United Kingdom on the Niankaramandougou, the Odienné, and the Ouelle-Prikro prospecting licenses; Equigold NL of Australia on PR 104, 105, and 119; GATRO-CI, the local subsidiary of Gencor Ltd. of South Africa, on PR 56 and 94; Goldivoire of Australia on PR 100 and 117; Jandera Resources NL, a subsidiary of Diversified Mineral Resources of Australia, on the Agbaou gold property; Leo Shield Resources Ltd. of Australia on the Korhogo permit; Oxford Resources Inc. of Canada on the Abengourou, the Alangua, the Koyekro, and the N'Douci properties; the joint venture of North Exploration (Overseas) Pty. Ltd. and Pan African Resources Corp. (PARC), a subsidiary of Golden Star Resources Ltd. of Canada, on the Tanda gold concession; PARC on several permits comprising the Comoé project; the joint venture of Randgold and New Mining Côte d'Ivoire on the Nielle, the Tehini East, and the Tehini West permits; Stanley Mining Services Ltd. of Australia; and Winslow Gold Corp. of Canada on PR 70.

Hyder Gold Inc. of Canada and New Sage Resources Ltd. of Canada relinquished their respective exploration concessions in Côte d'Ivoire. In 1998, Vauquelin Mines Ltd. of Canada dropped the Aboisso property after Société d'Exploration Minière en Afrique de l'Ouest of Canada terminated its option on the property. Trillion Resources Ltd. of Canada divested its Alepe and Odienné gold concessions, and Consolidated African Mining Corp. of Canada terminated its partnership with Omnium De Negoce of Côte d'Ivoire in the Mayana SARL, a venture that held four gold concessions.

Purity Metals of South Africa was exploring for manganese at Moka, about 150 km west of Abidjan, and near Ziemougoula, about 650 km north-northwest of Abidjan. The joint venture of Falconbridge International (Investments) Ltd. of Canada (60%), the Government (25%), and Trillion Resources (15%) continued exploration on the Touba-Biankouma laterite nickel prospect, approximately 500 km northwest of Abidjan.

Carnegie Minerals NL of Australia and PARC acquired diamond exploration licenses. Most existing diamond production at Séguéla and Tortiya was primarily artisanal.

In the petroleum sector, Ocean Energy of the United States (formerly United Meridian Corp.) operated the Lion and the Panthere Fields on block CI-11. Partners on the block included Daewoo Corp. of South Korea; Global Natural Resources Inc., a subsidiary of Seagull Energy Corp. of the United States; the International Finance Corp., an affiliate of the World Bank;

Petroci; and Pluspetrol S.A. of Argentina. Partnership interest varied from well to well in the fields. Santa Fe Energy Resources of the United States held block CI-24. The development plans for block CI-26, submitted by the joint venture of Addax Petroleum Ltd. of Switzerland, Ranger Oil Ltd. of Canada, and Tullow Oil plc. of Ireland, were approved in late 1998. The consortium of Apache International, a subsidiary of Apache Corp. of the United States; Electricité de France; Gaz de France; Petroci; and SAUR International of France were developing the Foxtrot natural gas prospect on block CI-27. Addax, Petroci, Ranger, and a subsidiary of Corral Petroleum Holding AB of Sweden held block CI-40. In 1997, the joint venture of Clyde Expro Plc, Energy Africa Ltd., Gentry International (Côte d'Ivoire) Inc., Petroci, Ranger Oil Côte d'Ivoire SARL, and T.C. Petroleum Inc. acquired block CI-102. In 1998, the joint venture of Ranger Oil (35%), Clyde Expro (35%), Gentry (17%), Petroci (10%), and T.C. Petroleum (3%) acquired blocks CI-101 and CI-103. Petroci and Seagull Energy Corp. of the United States held block CI-104. Ocean Energy, Petroci, and Shell Côte d'Ivoire Exploration Production B.V. of the Netherlands held the deepwater concession CI-105.

The Société Multinationale des Bitumes ran the 10,000-barrel-per-day (bbl/d) asphalt plant in Abidjan, and the Société Ivoirienne de Raffinage (SIR) managed the 59,000-bbl/d oil refinery. In 1998, an expansion to 88,000 bbl/d for the refinery and the divestment of some of the Government's equity interest in SIR were proposed.

The Governments of Côte d'Ivoire and Guinea commissioned a study of a proposed rail line from the Nimba iron deposit in

Guinea to the port of San Pedro in Côte d'Ivoire. The proposed railway would pass through the Touba-Biankouma nickel concession and bypass Liberia, which was the originally proposed export route.

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TABLE 1
CÔTE D'IVOIRE: ESTIMATED PRODUCTION OF MINERAL COMMODITIES 1/

Commodity 2/		1994	1995	1996	1997	1998
Cement	thousand metric tons	1,100 r/	1,000 r/	1,000 r/	1,100 r/	650
Diamond	carats	84,400	75,300	301,591 3/	306,665 3/	310,000
Gold	kilograms	1,860	1,983 3/	1,883 3/	2,419 3/	1,500
Natural gas	million cubic meters	--	36	547 3/	879	1,000
Petroleum:						
Crude	thousand 42-gallon barrels	--	2,000	5,833 3/	5,334 3/	7,300
Refinery products	do.	19,300	19,300	7,620 3/	7,850 3/	7,500
Tantalite	kilograms	--	500	500	1,350 3/	1,400

r/ Revised.

1/ Includes data available through August 16, 1999.

2/ In addition to the commodities listed, Côte d'Ivoire produced clays, crushed granite, manganese, sand and gravel, and stone. Information is inadequate to make estimates of output levels.

3/ Reported figure.

THE MINERAL INDUSTRY OF

DJIBOUTI

By Philip M. Mobbs

Occasional production of small quantities of clays, granite, limestone, marble, and sand and gravel, and small-scale commercial production of salt at Lake Assal constituted the mineral industry of Djibouti. Other mineral occurrences of potential economic interest included diatomite, geothermal fluids and mineral salts, gold, gypsum, perlite, pumice, and, possibly, petroleum. Most of these are near Lake Assal, although some gold indications were farther west near Yoboki and in the south near Ali Sabieh (Indian Ocean Newsletter, 1994). Oil interest was focused in the south and offshore in the Gulf of Aden.

Seven Star Minerals of the United States, in a joint venture with Quest International Resources Corp. of the United States, received gold and base-metal exploration permits for seven prospects in December 1997. The joint venture was dissolved in mid-1998 when Seven Star purchased Quest's interest. Seven Star continued surface exploration of the prospects.

As a result of the Eritrean-Ethiopian war, Djibouti recaptured

most of Ethiopian foreign trade that had passed through Eritrea in 1997. The Port Autonome International de Djibouti transshipped 1,205,461 metric tons (t) of Ethiopian cargo in 1998 compared with 278,350 t in 1997. Petroleum product imports, much of which were transported to Ethiopia by truck, jumped to 807,864 t in 1998 compared with 211,679 t in 1997.

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THE MINERAL INDUSTRY OF EGYPT

By Bernadette Michalski¹

Mineral and mineral-related industries continued to be a vital segment of the Egyptian economy. The petroleum and natural gas industries accounted for approximately 15% of the gross domestic product (GDP), which was \$76.95 billion in 1998; other extractive mineral industries accounted for more than 1% of the GDP. The decline in oil prices in 1998 seriously reduced revenues and resulted in a drop of Egypt's current account deficit to a deficit of \$2.12 billion in fiscal year 1997-98 ending June 30, 1998, from a surplus of \$550 million in fiscal year 1996-97 (Arab Petroleum Research Center, 1999, p. 76).

The Suez Canal was Egypt's third largest foreign exchange earner after tourism and hydrocarbon exports. Although transit fees were not increased in 1998 to encourage further usage, revenues, however, declined to \$1.75 billion in 1998 compared with \$1.80 billion in 1997. Revenues from the Suez-Mediterranean (Sumed) oil pipeline also declined to \$76 million in fiscal year 1997-98 from \$82 million for fiscal year 1996-97 (Arab Petroleum Research Center, 1999, p. 112).

The Mining and Petroleum Code Law No. 66 of 1953 and the Mining Code Laws No. 86 and No. 151 of 1956 are the bases of minerals legislation and for mineral exploration and exploitation in Egypt. Laws No. 43 of 1979 and No. 50 of 1981 provide the governorates and local councils with the power to administer quarries in their particular districts. Ministerial Decree No. 8 of 1990 was designed to assist the private sector in obtaining the required permits for mining.

Law No. 4 of 1994, the unified environmental legislation, empowers the Egyptian Environmental Affairs Agency to enforce environmental regulations. The law also provides that new mining or quarrying projects will require an environmental impact assessment.

The People's Assembly passed a law in 1998 allowing for partial privatization in the electricity networks. The Egyptian Electricity Authority is to offer 20% of regional generation and distribution works to private investors. The nation's total power was 15,400 megawatts (MW) at the close of 1998 with the commissioning of the second 660-MW unit of the Kureimat power station. According to the Ministry of Electricity, capacity was forecast to attain 24,000 MW by 2006 (Arab Petroleum Research Center, 1999, p. 104).

In 1998, oil and gas continued to be the dominant mineral sector. A variety of minerals was produced from the more than 600 mines and quarries. Among the nonfuel minerals produced, phosphate rock and iron ore remained the most important in terms of value. Most other mining activity was on a rather limited scale. (See table 1.)

In fiscal year, 1997-98, exports of all commodities totaled \$5.33 billion. Crude petroleum and refined products (mostly

fuel oil, naphtha, and jet fuel) were Egypt's leading exports. The value of crude oil exports for calendar year 1998 was \$1.2 billion—less than one-half the \$2.5 billion realized in 1997. Nearly 30%, or about 95 million barrels (Mbbbl), of the nation's crude oil output was available for export. Egypt exported six grades of crude, three of which, Suez Blend, Bas al-Bihar, and Zeit Bay, were rated 33° API; Belayim and Ras Budran were rated 26° API; and Ras Gharib, 24° API. In 1998, nearly one-half the total crude oil exports was absorbed by Asia (Arab Petroleum Research Center, 1999, p. 76). In 1998, the United States imported 4.2 Mbbbl of Egyptian crude oil (Energy Information Administration, 1999).

Most mining and mineral processing in Egypt was carried out by Government-owned mining companies. (See table 2.) Privatization had not progressed as rapidly as was originally planned. After several postponements, Egypt's state-run Holding Co. for Metallurgical Industries offered a total of 20% equity in its subsidiary Aluminium Co. of Egypt (Egyptalum), the nation's sole aluminum producer, to employees (10%) and private and institutional investors (10%) in February 1998 at \$22 per share. The Government retained 80% equity (Mining Journal, 1998).

Centamin NL of Australia was delineating the ore body at the Sukkari gold deposit southeast of Cairo on the Red Sea Coast. After completing 12,600 meters (m) of diamond drilling in the Amun and the Ra zones, Centamin reported that 311 metric tons (t) of gold may lie within the concession. The Ministry reported that production from the mine was expected to be more than 3 t in 1999 (Journal of Commerce, 1998).

Egyptian iron ore was mined in El Gedida area of El Bahariya Oasis in the Western Desert. The nearly 3 million metric tons per year (Mt/yr) produced from this deposit was destined for the Egyptian Iron and Steel Co., Hadisob's Helwan Iron and Steel Works near Cairo; this satisfied about three-quarters of Egypt's demand. About 1 Mt/yr was imported, mostly from Russia. The Egyptian Geological Survey & Mining Authority identified oolitic hematite iron ore deposits in the Eastern Desert about 85 kilometers (km) southeast of Aswan. A consortium, the Aswan Company for Development and Mining, proposed to develop the 300-million-metric-ton (Mt) iron ore deposit (Middle East Economic Digest, 1998c; Monitor, April 7, 1998, Egypt plans iron firm, accessed December 2, 1998, at URL <http://www.africanews.com/monitor/freeissues/07Apr98/business.html>).

Egypt had four nitrogenous fertilizer complexes, the largest of which was in Abu Qir; the others were in Kima, Suez, and Talkha. Abu Qir Fertilizer & Chemical Industries Co. brought a third plant on-stream at the end of 1998. It had a capacity of 330,000 metric tons per year (t/yr) of ammonia and 600,000 t/yr

¹Deceased.

of urea, boosting the company's total capacity to more than 1 Mt/yr of ammonia, 1.1 Mt/yr of urea, 600,000 t/yr of nitric acid, and 760 t/yr of ammonium nitrate. The nation's three other fertilizer complexes produced phosphate-based fertilizers. Phosphate mined in Abou Tartur yielded 2.2 Mt/yr of phosphate concentrates.

Natural gas has grown in importance to the economy in recent years and is expected to accelerate as a result of the development of numerous nonassociated gasfields. In 1998, the Western Desert supplied about 30% of Egypt's total natural gas production averaging 400 million cubic meters per day (Mm³/d). At yearend, the Obayed Field came on-stream, producing about 10 Mm³/d. Other large natural gas producers were the Abu Madi and the Abu Qir/Naf Fields, the Nile Delta region, and the Gulf of Suez associated gas-gathering network.

In 1998, crude oil production declined again, and domestic consumption rose by 9.4% to 172 million barrels per year (Mbbbl/yr). The Gulf of Suez remained the largest producing region, which accounted for 72% of total oil production. The second largest producing region was the Western Desert, which accounted for 16% of production [130,000 barrels per day (bbl/d)]. Production from the Sinai accounted for 5.8%, and the Eastern Desert, 5.3% (Arab Petroleum Research Center, 1999, p. 87-88).

Hydrocarbon exploration activity remained at a high level. Offshore exploration was conducted by Amoco Corp.; Apache Corp.; British Gas plc; Canadian Occidental Petroleum Ltd.; Coplex Resources N.L.; Forum Oil & Gas International; Egyptian Oil Co.; Kuwait Foreign Petroleum Exploration Co.; Marathon Co.; Petrobrel, a joint venture of the Egyptian Government and International Egyptian Oil Co. (IEOC); the Repsol Group; and the Royal Dutch/Shell Group. Exploration onshore was conducted by Apache; Epedeco; Gharib Oil Fields Co.; HBS; IEOC, a subsidiary of AGIP SpA.; National Exploration Co.; Pennzoil Co.; Repsol; Seagull Energy Corp.; Shell; and Sipetco. Nile Exploration of the United States acquired a 25% working interest in Block G of the Central Sinai Concession, which consisted of 1.84 million hectares (4.5 million acres) on the Sinai Peninsula bordering the eastern bank of the Gulf of Suez (GHP Exploration Corp., 1998, GHP Exploration enters Egyptian concession, accessed on February 9, 1998, at http://biz.yahoo.com/bw/980209/ghp_explor_1.html).

The Egyptian General Petroleum Corp. invited bids for nine oil and gas exploration blocks—three in the Mediterranean, five in the Gulf of Suez, and one in the Eastern Desert. The largest block was El-Arish offshore, covering 2,120 square kilometers off the North Sinai coast. The other Mediterranean blocks were North Bardavil, northeast of Port Said, and North Brullu, northeast of Rosetta (Middle East Economic Digest, 1998b).

In early 1998, Apache announced a new oil discovery in Alamein West containing recoverable unrisks reserves of 230 Mbbbl. The discovery's uppermost zone where perforations were between 2,694 and 2,697 m in the Dahab Formation yielded 38° API crude oil (Apache Corp., 1998, Apache's first well on Egypt's W. Mediterranean Concession discovers oil, accessed March 16, 1998, at http://biz.yahoo.com/prnews/98316/tx_apache_1.html).

The growth in natural gas production prompted downstream industries, such as petrochemicals and fertilizers, to embark on

expansion programs. Egyptian Petrochemicals Co. was expanding its Ameriya complex through the addition of a 300,000-t/yr ethylene cracker, a 250,000-t/yr low-density polyethylene plant, a 150,000-t/yr high-density polyethylene unit, and a 10,000-t/yr butene-1 unit. The new facilities were scheduled for completion in 2001 (Arab Petroleum Research Center, 1999, p. 109).

Private sector expansion reflected confidence in the country's long-term stability and freedom from the fear of nationalization. The budget for fiscal year 1998-99 will maintain the tight fiscal policy of recent years. The Government has set a target for GDP to reach \$79.6 billion by the end of the fiscal year. An estimated 71% will be accounted for by the private sector. The main investment sectors will include industry at \$4.3 billion, petroleum at \$1.6 billion, and electricity at \$0.9 million (Middle East Economic Digest, 1998a). Net earnings from oil exports declined because of a further drop in output, higher consumption, and the increased cost of petroleum products imports.

Egypt's six refineries produced a disproportionately high volume of fuel oil, which accounted for almost 50% of total refinery output. New refining projects were directed toward increasing production of lighter products and decreasing the need for imports. Among these was the Middle East Oil Refinery, a joint venture with Israel. The export refinery, under construction in Alexandria, was scheduled for completion in 1999 and will be the first refinery in the Middle East to comply with the European Union environmental standards. It will process about 10 Mbbbl/yr of Ras Gharib crude oil (24° API gravity) and about 25 Mbbbl/yr of imported crude oil. The refinery will include a 34,000-bbl/d hydrocracker geared to produce light products and a 33,000-bbl/d naphtha-processing unit.

Egypt's crude petroleum reserves were 3.5 billion barrels. Egypt's natural gas reserves were 1.02 trillion cubic meters and included recent new discoveries in the Nile Delta and the eastern Mediterranean Sea (Arab Petroleum Research Center, 1999, p. 75).

Within Egypt, railways totaled 5,110 km; roadways exceeded 51,925 km; and crude oil pipelines, 1,171 km. Commerce transiting the 193.5-km-long Suez Canal was critical to the Egyptian economy; further enlargement of the canal was completed in May 1998. The maximum size of transiting vessels, however, increased only marginally. The canal remained inaccessible to tankers of very large crude carrier and ultralarge crude carrier class except for transiting in ballast. Traffic in the Suez Canal continued to decline to 14,430 transits in 1997 from 14,731 transits in 1996. The 320-km-long Sumed pipeline complements the Suez Canal by linking Ain al-Sokhna on the Gulf of Suez to Sidi Krir on the Mediterranean coast. Large tankers were able to discharge all or part of their cargo into the pipeline, to transit the canal in ballast or partially laden, and to reload at the Sumed's northern terminal at Sidi Krir. In 1998, Saudi Arabia continued to be the pipeline's largest user, accounting for 60% of the crude oil carried through the pipeline (Arab Petroleum Research Center, 1999, p. 107).

The country was suffering from high levels of unemployment, and foreign investment and private sector development will be required if further progress is to be made. Following the structural reforms put forth by the International Monetary Fund,

the Egyptian economy has become more market oriented and less centralized. The program for 1998 included measures to stimulate the development of the private sector, tariff reductions, and ending import restrictions. The allowance of 100% cost recovery on mineral-resource concession agreements will undoubtedly favor future foreign investment. Although natural gas will be Egypt's main energy and revenue source in the future, development is time and capital intensive. Egypt planned to press ahead with rapid expansion of the natural gas industry. Oil companies were courting new exploration concessions, and the majority of wells drilled to date yielded oil or gas.

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TABLE 1
EGYPT: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997	1998 e/
METALS					
Aluminum metal	188,464	180,300	179,200	178,200	230,000
Copper, refined, secondary	4,300	4,400	4,600	4,600 e/	4,600
Iron and steel:					
Iron ore and concentrate thousand tons	3,870	2,043	2,429	2,744 r/	3,001 2/
Metal:					
Pig iron do.	1,148	1,062	1,100	1,000 e/	1,000
Ferroalloys: e/					
Ferrosilicon	44,000 2/	44,000	44,000	44,000	44,000
Ferromanganese	35,000	35,000	35,000	35,000	35,000
Direct reduced iron thousand tons	774	850	830	1,190	1,200
Steel, crude do.	2,622	2,642	2,618	2,717	2,800
Manganese	15,000 e/	1,207	15,000 e/	10,000	9,500
Titanium, ilmenite	--	57,000	124,000	125,000 e/	125,000
INDUSTRIAL MINERALS					
Asbestos	514	427	1,836	1,836 r/	1,900
Barite	419	500	---	---	---
Cement, hydraulic thousand tons	17,000	17,665	18,000 e/	18,100 r/	19,203 2/
Clays:					
Bentonite	2,379	1,930	1,100 r/	1,136 r/	1,545 2/
Fire clay e/	420,000	420,000	350,000 r/	331,265 r/ 2/	277,059 2/
Kaolin	180,000	293,381	258,725	258,869 r/	285,497 2/
Feldspar, crude	39,745	75,049	53,783	57,335 r/	325,654 2/
Fluorspar	514	551	700	775 r/	140 2/
Gypsum and anhydrite, crude thousand tons	1,481	2,032	2,000	2,423 r/	1,338 2/
Lime e/	750,000	750,000	750,000	800,000	800,000
Nitrogen:					
Ammonia, N content thousand tons	1,021	1,096	1,126	1,061	1,060
Urea, N content do.	420	480	489	445	445
Phosphate:					
Phosphate rock do.	632	765	808	900 e/	1,058 2/
P ₂ O ₅ content do.	178	207	222	240	320 2/
Salt do.	1,008	1,990	1,530	2,024 r/	2,387
Sodium compounds:					
Soda ash e/	50,000 2/	50,000	50,000	50,000	50,000
Sodium sulfate thousand tons	2,000 r/	2,000 r/	2,000 r/	2,118 r/	2,498 2/
Stone, sand and gravel: e/					
Basalt thousand cubic meters	600	600	600	883 r/ 2/	241 2/
Dolomite thousand tons	1,000	1,000	1,000	1,324 r/ 2/	3,444 2/
Granite, dimension cubic meters	13,000	13,000	20,000 r/	24,958 r/ 2/	35,817 2/
Gravel thousand cubic meters	7,200	7,200	10,500	12,033 r/ 2/	11,463 2/
Limestone and other calcareous, n.e.s. do.	18,000	18,000	18,300	23,559 r/ 2/	25,618 2/
Marble blocks (including alabaster) cubic meters	16,000	45,000	80,000 r/	127,767 r/ 2/	134,664 2/
Sand:					
Industrial sand (glass sand) thousand tons	740	740	850	505 r/ 2/	574 2/
Construction sand do.	22,000	22,000	22,000	21,250 r/ 2/	19,420 2/
Sandstone thousand cubic meters	200	200	200	66 r/ 2/	6 2/
Sulfur: e/					
Elemental, byproduct	8,000	10,000	8,000	4,453 2/	4,450
Sulfuric acid	100,000	591,000	680,000	500,000	500,000
Talc, steatite, soapstone, pyrophyllite	4,125	38,608	41,227	43,627 r/	39,720 2/
Vermiculite	1,659	483	447	447 r/	12,376 2/
MINERAL FUELS AND RELATED MATERIALS					
Coal e/ thousand tons	--	10	200	300	300
Coke e/ do.	1,200	1,200	1,200	1,200	1,200
Gas, natural:					
Gross production million cubic meters	11,900	15,942	16,800 e/	17,000 e/	16,670
Dry do.	9,000	12,536	13,183	13,349	13,300
Petroleum:					
Crude thousand barrels	327,040	335,800	336,500	319,000	316,090 2/
Refinery products:					
Liquefied petroleum gas do.	4,755	5,325	5,080	6,333	5,090
Gasoline and naphtha do.	36,900	38,450	40,185	44,065	43,465 2/

See footnotes at end of table.

TABLE 1--Continued
EGYPT: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997	1998 e/	
MINERAL FUELS AND RELATED MATERIALS--Continued						
Petroleum--Continued:						
Refinery products--Continued:						
Kerosene and jet fuel	thousand barrels	17,155	15,770	17,255	16,606	15,788 2/
Distillate fuel oil	do.	39,200	43,550	42,298	43,790	45,230 2/
Residual fuel oil	do.	90,080	80,350	85,787	86,100	87,625 2/
Lubricants	do.	1,580	1,645	1,645	1,729	1,820
Asphalt	do.	4,130	4,485	4,181	4,641	5,042 2/
Unspecified	do.	2,250	2,550	2,600 e/	2,400 e/	2,350
Total	do.	198,044	194,120	201,027	205,664	206,410

e/ Estimated. r/ Revised.

1/ Table includes data available through December 1, 1999.

2/ Reported figure.

TABLE 2
EGYPT: STRUCTURE OF THE MINERAL INDUSTRY IN 1998

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Aluminum	Aluminium Co. of Egypt (Government, 80%; private interests, 20%.)	Nag Hammadi	230.
Carbon black	Alexandria Carbon Black Co. (Egyptian Holding Co. for the Chemical Industry, 49%; Inco-Bharat, 36%, Grasim Industries, 15%.)	Alexandria	20.
Cement	Al Ameriyah Cement Co.	Ameriyah	2,100.
Do.	Asiut Cement Co.	Assiut	2,600.
Do.	Helwan Portland Cement Co. (Government, 73%; private interests, 27%.)	Helwan El Minya	2,800. 200.
Do.	Egyptian Cement Co. (Orascom Group, 40%; private interests, 40%; Holderbank Financiere Glaris Ltd., 20%)	70 kilometers east of Cairo	1,400.
Do.	Suez Cement Co. (Government, 77%; private interests, 23%)	Ain Sukhna Qattamia Waddi Hagoul	1,700. 1,200. 1,200.
Do.	Alexandria Portland Cement Co. (Government, 77%; private interests, 23%)	El Mex	800.
Do.	National Cement Co. (Government, 77%; private interests, 23%)	El Tabbin Beni Suef	4,000. 1,000.
Fertilizers, nitrogenous	Abu Qir Fertilizer & Chemical Industries Co. (private and public shareholders, 80.9%, Egyptian General Petroleum Corp., 19.1%)	Abu Qir 1 Abu Qir 2 Abu Qir 3	330 (ammonia). 510 (ammonia nitrate). 330 (ammonia). 790 (urea). 390 (ammonia). 580 (urea).
Do.	Société El-Nasr d Engrais et d'Industries Chimiques (Government, 100%)	Suez	146 (ammonia). 450 (nitric acid). 365 (ammonium nitrate).
Do.	do.	Talkha	330 (ammonium nitrate). 570 (ammonia & urea).
Do.	Egyptian Chemical Industries (Government, 100%)	Kima	330 (ammonia). 600 (nitric acid). 800 (ammonium nitrate).
Iron and steel	Egyptian Iron and Steel Co., Hadisob. (Government, 100%)	Helwan steel plant	1,500.
Do.	Alexandria National Iron and Steel Co. (Government, 100%)	El Dikheila plant	1,100.
Natural gas million cubic meters	Egyptian General Petroleum Corp. (EGPC) (Government, 100%)	Abu Madi Badreddin- 3 Abu Qir/Naf Ras Shukheir	3,800. 3,000. 1,900. 1,600.
Do.	do. Grupo Khalda (Repson, 50%, Apache Oil Co., 40%; Samsung, 10%)	Khalda	24.
Petroleum, crude million 42-gallon barrels	Gulf of Suez Oil Co. (EGPC, 50%; Amoco, 50%)	October, Suez Gulf El Morgan, Suez Gulf	45. 27.
Do.	do. Belayim Petroleum Co. (EGPC, 50%; International Egyptian Oil Co., 50%)	Belayim, Suez Gulf	65.
Do.	do. Suez Oil Company (EGPC, 50%; Deminex, 25%; Repsol, 25%)	Ras Budran, Suez Gulf	15.
Petroleum, pipeline	do. Arab Petroleum Pipeline Co. (Egypt, 50%; Saudi Arabia, 15%; Kuwait, 15%; United Arab Emirates, 15%; Qatar, 5%)	Ain al-Sokhna to Sidi Kir	875.
Petroleum, refined	do. Cairo Petroleum Refining Co. (Government, 100%)	Mostorod Tanta	42. 15.
Do.	do. Alexandria Petroleum Co. (Government, 100%)	Alexandria	42.
Do.	do. El-Nasr Petroleum Refining Co. (Government, 100%)	Suez	36.
Do.	do. Ameriya Petroleum Refining Co. (Government, 100%)	Ameriya	27.
Do.	do. Suez Petroleum Processing Co. (Government, 100%)	Suez	21.
Do.	do. Asyut Petroleum Refining Co. (Government, 100%)	Asyut	18.
Phosphate rock	Egyptian Organization of Industrial and Mining Complexes (Government, 100%)	Abu Tartur	2,200.

THE MINERAL INDUSTRY OF EQUATORIAL GUINEA

By Philip M. Mobbs

The Republic of Equatorial Guinea consists of Rio Muni on the African mainland and a number of islands and islets, including the volcanic island of Bioko in the Gulf of Guinea, the islands of Corisco, Elobey Chico, Elobey Grande, and Mbañe in Corisco Bay, and the volcanic island of Annobón in the South Atlantic Ocean. The petroleum sector has dominated the country's economy since 1996, when production of crude oil from the Zafiro Field began. Petroleum accounted for 42% of gross domestic product (GDP) in 1996 compared with 7% in 1992 and 0% in 1990. Annual GDP growth has rocketed from 5% in 1994 to 29% in 1996 and continuing to 76% in 1997 when the GDP was estimated to be about \$500 million (International Monetary Fund, 1998; Ministry of Mines and Energy, 1998).

Mineral resources were the property of the State. Decree Law No. 9/1981 regulated mining activity, except aggregate and radioactive minerals. The royalty on gold production was 3%, and other nonfuel mineral production was subject to a royalty rate up to 5%. Petroleum exploration and production in Equatorial Guinea were regulated by the Decree Law No. 7/1981, as amended. The model production sharing contract was revised and updated in 1998. There was a minimum 10% royalty on petroleum production and provisions for the Government to participate in exploration and production ventures. Income tax started at a 25% rate. Equatorial Guinea was a member of the Western African Monetary Union and African Legal Accord, Organization pour l'Harmonization du Droit des Affaires en Afrique (Ohada). Ohada was initiating a transparent commercial and corporate legal system across member African states.

Several mineral and geologic surveys of the 25,650-square-kilometer (km²) mainland enclave, Rio Muni, have been conducted by various organizations, including the Soviet Union in the 1970's, and France's Bureau de Recherches Géologiques et Minières and Guineo Española de Minas S.A., a joint venture of the Equatorial Guinean Government and Adaro National Mining Research Co. of Spain, in the 1980's. UMC Equatorial Guinea Corp., a subsidiary of United Meridian Corp. of the United States, had an exclusive mineral development agreement for the entire Rio Muni area that expired in 1998 (UMC Equatorial Guinea Corp., 1997). United Meridian and its subsidiaries were acquired by Ocean Energy Inc. of the United States in March 1998.

In preparation for the 38,000-km² deepwater lease sale scheduled for early 1999, the Government had about 7,500 kilometers (km) of seismic data acquired over previously unexplored areas west of Rio Muni and south and southwest of Bioko.

The joint venture of the American firms, CMS Oil & Gas Co. (formerly CMS NOMEKO Oil & Gas Co.); Samedan Oil Corp., a subsidiary of Noble Affiliates Inc.; Globex International; and

Axem Resources Inc. were producing about 7,000 barrels per day (bbl/d) of natural gas condensate from the Alba Field in the Gulf of Guinea, 36 km northwest of Bioko. The consortium drilled the Alba-5 gas well in 1998. In 1997, the East Luba-1 gas well and the Riaba-1 oil well were drilled. The consortium's proven oil and natural gas condensate reserves were 63 million barrels (Mbbl). Proven natural gas reserves were posted as 26 billion cubic meters (Noble Affiliates Inc., 1998).

Samedan has operated a 2,400-bbl/d-capacity liquified petroleum gas plant on Bioko, fed by natural gas production from the Alba Field, since startup in January 1997. About 3 million cubic meters per day of residual dry gas, presently (1998) being flared, was targeted as the feedstock for a proposed 2,500-metric-ton-per-day-capacity methanol plant. During 1998, Atlantic Methanol Production Co. was formed by CMS (45% equity interest), Samedan (45% equity interest), and the Government (10% carried interest) to build and operate the methanol plant, estimated to cost \$424 million.

On offshore Block B, about 60 km west of Bioko, Mobil Oil Equatorial Guinea Inc. (71.25%), a subsidiary of Mobil Corp. of the United States, continued development of the Zafiro Field for partners Ocean Energy (23.75%) and the Government (5%). The Government acquired its interest in a March 1998 renegotiation of the production-sharing agreement. Mobil discovered the Zafiro Field in water depths ranging from 150 to 250 meters (m) in March 1995; the field was producing by August 1996. By the end of 1998, production from this field was constrained by the 80,000-bbl/d capacity of the floating production, storage, and offloading (FPSO) vessel, the *Zafiro Producer*. The consortium proposed to expand the production facilities to 120,000-bbl/d capacity with the installation of a 40-slot platform on the Jade area of the field and additional modifications, including a gas lift module, on the FPSO. Recoverable reserves were estimated to be about 300 Mbbl of oil (U.S. Energy Information Administration, August 1998, Equatorial Guinea, accessed May 12, 1999, at URL <http://www.eia.doe.gov/emeu/cabs/eqguinea.html>).

On Block B, Mobil drilled nine successful development wells and three exploratory wells in 1997. In 1998, Mobil drilled three successful development wells and eight exploratory wells, three of which were successful.

On Block D between the Alba and Zafiro Fields, UMC (75%) and SK Corp. of South Korea (formerly Yukong Ltd.) (25%) drilled the Tavorita-1 and the Tavorita-1A in 1997. In 1998, SK relinquished its interest in the block. In 1998, the Government acquired a 6% interest in Block D; Ocean Energy (94%) subsequently drilled the Ambar-1 and the Estauroliita wells.

Triton Energy Ltd. of the United States acquired Blocks F and G offshore Rio Muni in 1997. In 1998, the company acquired

2,500 km of seismic data on these blocks that extended to a water depth of 1,500 m. Also in 1998, Elf Aquitaine Guinée Equatoriale, a subsidiary of Elf Aquitaine of France, was awarded a 6,800-km² concession southwest of Bioko, in water depths of 1,000 to 2,700 m.

Oilfields are not constrained by international frontiers. Under negotiation was a dispute with Nigeria concerning the Zafiro Field. Nigeria claimed that the field extends into its territory and that Mobil was depleting their oil (U.S. Energy Information Administration, August 1998, Country analysis brief—Equatorial Guinea, accessed May 12, 1999, at URL <http://www.eia.doe.gov/emeu/cabs/eqguinea.html>).

Equatorial Guinea's maritime borders with Cameroon, Gabon, Nigeria, and São Tomé e Príncipe are not well defined, opening the possibility of additional boundary disputes.

The initiation of petroleum production has resulted in a significant economic expansion in Equatorial Guinea because it simultaneously severely overtaxed the nation's infrastructure. The financial stimulus has allowed the Government to consider an infrastructure improvement program and to evaluate the diversification of the national economy (Ministry of Mines and Energy, 1998; U.S. Energy Information Administration, August 1998, Country analysis brief—Equatorial Guinea, accessed May 12, 1999, at URL <http://www.eia.doe.gov/emeu/cabs/eqguinea.html>). The untested deepwater turbidite area, south and southwest of Bioko, offers significant potential for the

discovery of hydrocarbons; however, enthusiasm for expensive deepwater prospects may be subdued by low international oil prices. The scarcity of deepwater drilling rigs also will restrict rapid exploratory drilling of much of the nation's petroleum licensed area (Plowden, 1998).

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TABLE 1
 EQUATORIAL GUINEA: ESTIMATED PRODUCTION OF MINERAL COMMODITIES 1/

(Thousand 42-gallon barrels unless otherwise specified)

Commodity 2/	1994	1995	1996	1997	1998
Crude oil and condensate	1,800	2,300	6,300	21,000	30,000
Liquified petroleum gases 3/	--	--	--	450	660
Natural gas 4/ million cubic meters	--	--	--	44	78

1/ Includes data available through May 14, 1999.

2/ In addition to the commodities listed, Equatorial Guinea presumably produced a variety of crude construction materials (clay, gravel, and sand). There is also artisanal production of gold, but output is not reported, and available information is inadequate to make reliable estimates of output levels.

3/ Production began in January 1997.

4/ Total natural gas production is estimated at about 3 billion cubic meters per year. Prior to January 1997, all produced natural gas was flared. Since January 1997, produced natural gas is processed to recover liquified petroleum gases.

THE MINERAL INDUSTRY OF

ERITREA

By Philip M. Mobbs

Agricultural production accounted for about 50% of Eritrea's gross domestic product, and the output of energy and minerals sectors contributed about 1% (U.S. Embassy Asmara, March 1998, Eritrea's economy—Sector report—Mining and energy sectors offer opportunity for U.S., accessed September 16, 1998, at URL <http://usiahq.usis.usemb.se/abtusia/posts/ET9/wwwhc01x.html>).¹ The Government, interested in the potential economic enhancement that mineral production and beneficiation could provide, continued to seek international investment in its mineral industry. The petroleum operations code was issued in July 1993; a general investment code was issued in 1994; and Mining Proclamation No. 68/1995, Mining Income Tax Proclamation No. 69/1995, and Regulations on Mining Operations Legal Notice 19/1995 were issued in March 1995. Royalties were 5% on precious metals and 3.5% on other minerals, the mining corporate income tax rate was 38%, and there was no export tax on minerals. The Government could acquire 10% free equity interest in new mining investments, and acquisition of an additional 20% equity in the venture by the Government was negotiable.

War between Eritrea and Ethiopia erupted in May 1998 and effectively eliminated mineral exploration in southern Eritrea. Because of the war, the joint venture of Anglo American Prospecting Services (Proprietary) Ltd. of South Africa (60%) and Rift Resources Ltd. of Canada (40%) declared force majeure on exploration operations on the Augaro gold property in western Eritrea. The joint venture of Dragon Mining NL of Australia, Genesis Resources NL of Australia, and Africa Wide Resources Ltd. of Hong Kong applied for exploration permits on the Zara gold project. Eritrean-Timmins Resource Ventures Plc, a subsidiary of Rift Resources, continued exploration on the Ketina, Nefasit-Mount Subub, and Tekeze exploration licenses. Marchmont Gold Corp. of Canada acquired 75% interest in Eritrean Minerals Corp. when it purchased Gold Corp. of Africa. Nevsun Resources (Eritrea) Ltd. of Barbados, a subsidiary of Nevsun Resources Ltd. of Canada, acquired an option on the Akurdet 1-4, Bisha, and Okreb gold prospects from Ophir Ventures Inc. Pan African Resources Corp. of Canada, a subsidiary of Golden Star Resources Ltd., relinquished its Galla Valley license. In July, Rift Resources acquired an option on the Adi Nefas gold and polymetallic massive sulfide concession of LaSource Développement SAS, a subsidiary of LaSource Compagnie Minière SAS of France.

Other companies with Eritrean exploration licenses included Phelps Dodge Exploration Corp. of the United States; Sanu Resources Inc.; Tan Range Exploration Corp. of Canada on the Asmat, Erota, and Melebsc concessions; and WMC (Overseas) Pty. Ltd. of Australia. Other mineral occurrences in Eritrea included asbestos, barite, beryl, copper, feldspar, iron deposits,

kaolin, lead, nickel, petroleum, potash, sylvite, and zinc (Ministry of Energy and Mines, 1997).

The Government and Kaengnam Enterprises of South Korea initiated a joint venture to construct a 400,000-metric-ton-per-year cement plant. Ethiopia had been a major Eritrean salt purchaser; with the onset of the war, Ethiopia discontinued salt imports from Eritrea.

The joint venture of Anadarko Eritrea Co., a wholly owned subsidiary of Anadarko Petroleum Corp. of the United States, (50%); Azienda Generali Italiana Petroli S.p.A. of Italy (30%); and Burlington Resources Inc. of the United States (20%) drilled two dry exploration wells on the offshore Zula block.

The nation's infrastructure, which suffered severe damage from the 30-year Ethiopian civil war that ended in 1991, was being rehabilitated. The 308-kilometer railroad from Ak'orda through Asmara to Massawa was being rebuilt, and the Red Sea ports at Assab and Massawa were being renovated. In May, transshipment of Ethiopian freight ceased at the outbreak of the war, primarily affecting Assab where 98% of the cargo had been from Ethiopia (Africa Online, August 31, 1998, War wipes out Eritrean ports trade, accessed January 8, 1999, at URL <http://news.africaonline.nu/view.asp?ID=3218>).

International mining investment was focused on the sites of historical operations in Eritrea. The war, disappointing results of exploration on some initial license areas, and the drop in the price of gold made 1998 a frustrating year for the Government and the exploration companies.

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¹This U.S. Information Agency URL has been moved to <http://www.usia.gov/abtusia/posts/ET9/wwwhc01x.html>.

TABLE 1
ERITREA: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997	1998
Basalt	114,483	233,555	509,300	489,686 r/	403,219
Cement	45,000 e/	49,947	47,031	60,000 e/	50,000 e/
Clays:					
Common	62,970	88,676	81,600	80,000 e/	80,000 e/
Kaolin	5,231	3,200	2,620	4,670 r/	3,809
Coral	74,404	78,603	69,269	96,535 r/	245,112
Feldspar e/	6,823 2/	--	--	--	--
Gold kilograms	78	59	98	612 r/	573
Granite	43,803	82,007	130,000	111,062 r/	249,829
Gravel	80,622	1,172,500	1,715,000	798,055 r/	941,129
Gypsum	15	20	23	20 e/	20 e/
Lime e/	6,294 2/	6,955 2/	7,000	7,000	6,000
Limestone 3/	-- r/	8,218 r/	4,552 r/	5,585 r/	4,077
Marble 4/	190	292,400	218,300	220,000 e/	200,000 e/
Pumice	183	233	300 e/	754 r/	391
Quartz	488	276	870	604 r/	731
Salt	207,836	254,700	200,412	252,073 r/	114,137
Sand e/	464,883 2/	911,508 2/	1,000,000	2,000,000	1,000,000
Silica sand	38,014	966,200	1,481,100	1,500,000 e/	1,500,000 e/
Talc	3	--	--	--	--
Petroleum products thousand 42-gallon barrels	5,150	4,336	4,500	3,000	--

e/ Estimated. r/ Revised.

1/ Includes data available through August 3, 1999.

2/ Reported figure.

3/ For other than cement.

4/ In addition to tonnage listed in this table, 108,545 square meters of marble were produced for the construction industry in 1995.

THE MINERAL INDUSTRY OF

ETHIOPIA

By Philip M. Mobbs

The mineral industry was a minor contributor to Ethiopia's agrarian-based economy. In 1998, mining and mineral-based production accounted for less than 1% of the nation's \$6.6 billion gross domestic product (Walta Information Center, [undated], Background to the mineral, petroleum, and energy sector, accessed November 1, 1999, at URL <http://www.telecom.net.et/~walta/profile/html/minbg.html>; World Bank, September 22, 1999, At-a-glance—Ethiopia, accessed November 1, 1999, via URL <http://www.worldbank.org/data/countrydata/countrydata.html>).

After a month-long dispute with Eritrea concerning national boundaries, the altercation erupted into war on June 3. Popular Ethiopian opinion concerning the objectives of the war included regaining the disputed area occupied by Eritrean troops, as well as retaking the Red Sea port of Assab, ceded to Eritrea when that nation became independent from Ethiopia in 1993 (Wrong, 1998; Addis Tribune, June 12, 1998, The economic causes and implications of the Ethio-Eritrean War, accessed June 12, 1998, at URL <http://addistribune.ethiopiaonline.net/archives/1998/06/12-06-98/Eco-297.htm>).

In 1998, Ethiopian exports were valued at \$602 million. Gold was the most significant mineral export. Fertilizer and refined petroleum products were the nation's most significant mineral-related imports, accounting for 16% of total imports that were valued at \$1,519 million (World Bank, September 22, 1999, At-a-glance—Ethiopia, accessed November 1, 1999, at URL <http://www.worldbank.org/data/countrydata/countrydata.html>).

The Ministry of Mines and Energy administered mineral-resources development in Ethiopia. The Ethiopian Institute of Geological Surveys conducted mapping and mineral prospecting. The state-owned Ethiopian Mineral Resources Development Corp. (EMRDC) was involved in development and production of mineral resources. All foreign investment was licensed by the Ethiopian Investment Authority. Mining Proclamation 52/1993, the Mining Income Tax Proclamation 53/1993, Mining Operations Regulation 182/1994, Proclamation 22/1996, Proclamation 23/1996, and Proclamations 37/1996 and 115/1998, the investment laws, formed the legal basis for mining in Ethiopia. The state retained title to all land. Proposed mining operations required national and regional governmental approval. The National Government could acquire 2% participation interest in mining ventures and levied a 35% income tax on mining operations. The royalty rate was 5% on precious metals and 3% on other minerals.

The downturn in international gold prices during 1998 and resultant reduction in the availability of financing for mineral exploration and development projects interfered with the Government's attempt to increase foreign investment in Ethiopia's mineral sector. Exploration and production operation in northern Ethiopia were severely hampered by the war. Regional insurgencies also periodically threatened mining

operations (Africa Energy & Mining, 1999b).

National Mining Corp., an associate company of the Midroc Group of Ethiopia, was producing from the 3,000-kilogram-per-year (kg/yr)-capacity Lega Dembi gold mine. Midroc acquired the mine from the Government in March for \$172 million. Midroc planned additional exploration and eventually to expand the mine's capacity to 5,000 kg/yr (Addis Tribune, August 28, 1998, Lega Dembi gold mines to produce 2,800 kilograms of gold in the first year, accessed September 25, 1998, at URL <http://addistribune.ethiopiaonline.net/Archives/1998/28-08-98/Gold.htm>).

Some companies with northern Ethiopian concessions temporarily abandoned their operations because of the war (U.S. Department of State, [undated], Ethiopia's mineral prospects, accessed November 5, 1999, at URL <http://www.telecom.net.et/~usis-eth/wwwhec09.htm>). EMRDC continued gold exploration in the Oromia region. International Roraima Gold Corp. of Guyana continued exploration of the Koko-Kenticha property in the Adola gold belt of southern Ethiopia. Tan Range Exploration Corp. of Canada drilled the Tulu Kapi concession and continued exploration for gold on the Hagere Mariam and the Tulu Dimtu concessions. The joint venture of Canyon Resources Africa Ltd., a subsidiary of Canyon Resources Corp. of the United States, and JCI Ltd. of South Africa investigating the Megado Serdo, the Meleka Abeba, and the Tendaho Graben area properties was dissolved because the mining interests of JCI were being restructured in 1998. Canyon subsequently suspended operations because of the war. JCI continued evaluation of the Chambi, the Katta-Gulliso, and the Werseti-Gudba licenses.

The joint venture between Ashanti Goldfields Co. Ltd. of Ghana and Ezana Mining Development plc of Ethiopia discontinued exploration of the Hawsen and the Shire prospects in northern Ethiopia. Emerging Africa Gold Inc. of Canada wrote-off its remaining Ethiopian license. Pan African Resource Corp., a subsidiary of Golden Star Resources Ltd. of Canada, relinquished the Dul Mountain gold concession, and Rift Resources Ltd. of Canada wrote off the Humera, the Moyale, and the Negele-Bul Bul gold exploration licenses.

Cement production was primarily from the state-owned Ethiopian Cement Corp.'s Addis Ababa clinker-grinding plant and Mugher cement factory. In 1998, the Ethiopian Privatization Agency collected bids for the 20,000-metric-ton-per-year-capacity Dire Dawa cement factory, the smallest of the state-owned cement plants.

Privately owned operations produced construction materials, including brick clay; limestone and shale mined for cement production; gypsum for cement and plaster; sand and gravel; crushed stone; and for export, dimension stone. EMRDC produced feldspar, kaolin, silica sand, and talc. Abay Natural Resources Development of Ethiopia, a subsidiary of United

States-based Abay Resources Technology International, entered into an agreement to explore for opal in Amhara regional state. The exploration application was forwarded to the Ethiopian Council of Ministers for approval. In August, the Government issued a tender for bids on the Coal Phosphate Fertilizer Complex Project, a feasibility study of fertilizer production using the coal reserves at Yayu in Oromia regional state.

Hunt Oil Co. of the United States held a production-sharing contract in the Ogaden region. The Calub Gas Share Co., a venture of the Federal Government (90%), regional governments, and private investors, held the eight-well Calub Field, in the Ogaden region. The field's reserves were estimated to be 68 billion cubic meters (Africa Energy & Mining, 1999a). In 1998, the Government collected bids on the privatization of 51% equity interest in Calub. The submitted bids were being evaluated at yearend.

The physical infrastructure of Ethiopia, a landlocked East African nation of about 61 million persons, had limitations, primarily associated with damage from the 30-year civil war. Roads from Addis Ababa to the port of Assab, Eritrea—about 1,000 kilometer—had carried almost 90% of Ethiopia's exports in 1997; however, after the 1998 border conflict with Eritrea began, most of the country's exports and imports were shifted to secondary roads leading to the Port Autonome International de Djibouti, on the Red Sea in Djibouti. Rehabilitation of the national road network and upgrading the road to Djibouti were underway at yearend; however, the expulsion of Eritrean contractors delayed some infrastructure projects (Indian Ocean Newsletter, 1998). The Ethiopian Government also encouraged increased use of the 781-km railroad from Addis Ababa to Djibouti. Rehabilitation of locomotives and the rolling stock of the 100-year old Chemin de Fer Djibouto-Ethiopien, operated as a joint venture by the Djiboutian and the Ethiopian Governments, was aided by financing provided by Agence Française de Développement.

The sudden influx of Ethiopian cargo into the port of Djibouti resulted in severe port congestion. Some cargo was diverted to Mombasa, Kenya, and to Berbera in the self-declared Republic of Somaliland (Addis Tribune, July 24, 1998, Ethiopian cargo worth millions of birr still impounded at Assab and Mitswa ports, accessed October 2, 1998, at URL <http://addistribune.ethiopiaonline.net/Archives/1998/07/24-07-98/Port.htm>; Daily Nation, December 11, 1998, Kenya to handle Addis cargo, accessed December 17, 1998, at URL <http://www.nationaudio.com/News/DailyNation/111298/Business/Business2.html>).

Ethiopia's electrical generating capacity of 371 megawatts (MW) was of limited availability outside urban areas. Primarily derived from hydroelectric plants, electrical power was also generated by small diesel plants in outlying areas, and in May 1998, an 8.5-MW geothermal electricity generating plant was brought on-line. With 27 additional electrical power projects underway, the national electricity generating capacity was expected to reach 658 MW by 2003 (Addis Tribune, September 18, 1998, 1-2 billion birr allocated for increasing Ethiopia's electric power, accessed September 25, 1998, at URL <http://addistribune.ethiopiaonline.net/Archives/1998/09/18-09-98/Power.htm>).

The Government, through the Ethiopian Investment Authority and the Ministry of Mines and Energy, was promoting mineral sector investment, especially development of bentonite, coal, columbium (niobium), diatomite, natural gas, gold, granite, iron ore, marble, nickel, oil, phosphate, potash, silica sand, soda ash, and tantalum resources. The Government anticipated that fertilizer production would partially satisfy the expanding demand from the agriculture sector and that mineral exports could significantly increase the nation's foreign exchange earnings and diversify the country's coffee-based economy.

Economic development and export growth are expected to increase as improvements in the Nation's transportation infrastructure are made and the border dispute with Eritrea is resolved. The long-term outlook was for increased activity by domestic and international minerals companies, eventually resulting in increased utilization of Ethiopia's considerable resources.

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Ministry of Mines and Energy

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Major Publications

- Ministry of Mines and Energy, undated, Geology, mineral occurrences, mining policy and investment opportunities in Ethiopia: Ministry of Mines and Energy, Addis Ababa, Ethiopia, 24 p.
Techno-Economic Consulting, Inc., 1994, Introducing the mineral wealth of Ethiopia, United Nations Department of Development Support and Management Services, New York, 19 p.
Wegner, Hans-Ulrich, and Häusser, Ilse, 1996, Äthiopien: Hannover/Berlin, Bundesanstalt für Geowissenschaften und Rohstoffe, Rohstoffwirtschaftliche Länderberichte 39, 103 p. [In German.]

TABLE 1
ETHIOPIA: ESTIMATED PRODUCTION OF MINERAL COMMODITIES 1/ 2/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997	1998
Cement, hydraulic	464,396 3/	611,437 3/	663,000 r/	750,000 r/	775,000
Clays: 4/					
Brick	10,000	7,000	7,000	6,000	6,000
Kaolin (China clay)	8	15	15	16	15
Diatomite	150 3/	150 3/	150 3/	150 3/	125
Feldspar	4,000	4,000	4,000	5,000	5,000
Gold, mine output, Au content kilograms	2,370	4,500 3/	2,500 3/	3,000 3/	2,500
Gypsum and anhydrite, crude	30,700	124,000 3/	124,000 3/	120,000 3/	100,000
Lime	2,727 3/	3,091 3/	3,100 3/	2,500 3/	3,000
Platinum, mine output, Pt content 5/ grams	--	100	100	100	80
Pumice 4/	127,000	360,000	360,000	325,000	325,000
Salt, rock	5,000	5,000	5,000	5,000	5,000
Scoria	190,000	240,000	250,000	250,000	250,000
Soda ash, natural	2,150 3/	20,000 3/	20,000 3/	15,000 3/	15,000
Stone, sand and gravel: 4/					
Construction stone, crushed thousand tons	300	750	750	750	1,000
Dimension stone 6/	42,000	38,000	38,000	40,000	130,000
Limestone 7/ thousand tons	700	3,215 r/	3,300 r/	3,300 r/	3,400
Sand 8/ do.	6,040	1,600	1,600	1,600	2,500
Silica sand	5,000	6,000	6,000	7,000	7,000
Tantalite, concentrate (40% Ta ₂ O ₅)	26 3/	20 3/	20 3/	20 3/	20

r/ Revised.

1/ Data are for year ending July 7 of the year listed.

2/ In addition to the commodities listed, some lignite, semiprecious gemstones, steel semimanufactures, and talc reportedly were produced, and silver was reportedly contained in gold ingots from the Lege Dembi Mine, but information is inadequate to estimate output reliably.

3/ Reported figure.

4/ When reported as volume or pieces, conversions to metric tons are estimated.

5/ No platinum production was officially reported after 1988. However, some artisanal platinum probably continued to be produced, and platinum was also reported by others as being contained in gold ingots from the Lege Dembi gold mine, which started up in 1990.

6/ Includes marble.

7/ Apparently does not include production for cement manufacture for 1994. Normally, the manufacture of 1 metric ton of cement requires from 30 to 50 kilograms of gypsum as well as from 1.3 to 1.8 metric tons of limestone and up to 0.5 metric ton of shale and/or clay.

8/ May include gravel.

THE MINERAL INDUSTRY OF

GABON

By George J. Coakley

The equatorial African nation of Gabon has an area of 257,670 square kilometers and supported a population of about 1.2 million in 1998, with a gross domestic product (GDP) per capita of \$6,400 based on 1998 purchasing power parity data. The mineral industry was dominated by crude petroleum production, which accounted for about 60% of Government revenues and more than 40% of the GDP. Following petroleum and timber, manganese and uranium were the major exports. Total exports of all goods were approximately \$2.1 billion, with petroleum accounting for about 80% and manganese for 5% in 1998. Resources of gold, iron ore and phosphate were known.

A new mining code was drawn up by the Government in 1997. The new code is designed to promote new exploration and to establish rules to protect the environment. Operations would be tax free during the research and prospecting stages. Prospecting License tenure would be reduced from 5 to 2 years and would be renewable once. Mining Concessions tenure would be reduced from 75 to 25 years but would be renewable for as long as minable deposits lasted (Mining Journal, 1998). Final action on the new code was pending in Parliament during 1998. Subject to its replacement, the basic mining law of Gabon was the 1962 Mining and Petroleum Code, law 15/62, as modified in 1968 by law 16/68 and in 1970 by Decree No. 981. The mining fiscal regime is now governed by Ordinance No. 38/79/PR. Petroleum exploration and exploitation were further regulated by laws 14/74 and 14/82. The Ministère des Mines, de l'Énergie, et du Pétrole administered the mineral industry. Mineral concession contract terms emphasized spending commitments by private companies. Crude petroleum production-sharing agreements provided for Government participation as a joint-venture partner, in addition to a royalty of 20%. The Gabonese environmental law, law 16/93 Relating to the Improvement and Protection of the Environment, contained a section that addresses mining and petroleum activities. The Direction Générale de l'Environnement was responsible for environmental oversight.

The Government had a share in nearly every mineral venture, ranging from 25% to more than 90% ownership. The Government, however, was seeking to diversify its partnership mix by soliciting new international participants. Among the foreign companies active in Gabon's mineral industry were subsidiaries of French companies and several U.S. firms, which were active in petroleum exploration.

Commodity Review

Metals

Columbium (Niobium).—During 1998, Reunion Mining plc of the United Kingdom, which was subsequently acquired by

Anglo American plc in 1999, initiated a feasibility study to examine the potential for producing columbium (niobium)-rich pyrochlore concentrate from the Mabounié carbonatite complex near Lambaréné in the west-central portion of the country. Columbium is used as a ferrocolumbium alloy in steelmaking. The project would have a capital cost of about \$50 million and produce 6,000 metric tons per year (t/yr) of ferroniobium (ferrocolumbium). The carbonatite contains 360 million metric tons (Mt) of niobium and phosphate ore grading 1.02% niobium oxide and 24% phosphorous pentoxide. The high-grade niobium zone contains 41.2 Mt of ore grading 1.9% niobium oxide. By developing the project, Reunion can earn a 42% interest in the niobium-rich portion of the carbonatite complex. An operating company, Niobium Resources plc., will be formed by Reunion (60%), Treibacher Industrie AG of Austria (20%), and a private Dutch company (20%). Niobium Resources will have a 70% interest in the Gabonese company Societe Minière de la Mabounie, which will hold the mineral rights to the property; the remaining 30% interest will be held by a private Gabonese company, Somipar (Ruffini, 1998).

Gold.—Several junior exploration companies were exploring for gold, including Lafayette Mining NL of Australia at its Moukanda prospect, and Searchgold resources Inc. of Canada on the Bakoudou gold property, where it had outlined a 20-hole drill-indicated resource of 3.94 Mt with an average grade of 6.4 grams per metric ton (Searchgold Resources Inc., January 19, 1999, First resource estimate in Gabon—Searchgold resources, press release, accessed January 22, 1999, at URL <http://www.infomine.com/index/pr/Pa015726.PDF>).

Manganese.—Compagnie Minière de l'Ogooué S.A. (Comilog), owned by the Eramet Group of France (61%), operated the Moanda manganese mine near Franceville. In 1998, manganese production of 2.09 Mt increased by 10% from 1997, and sales of 2.05 Mt remained relatively level with sales volumes of the past several years. Nearly 50% of sales went to Comilog's in-house subsidiaries. During 1998, Comilog was negotiating to franchise-out the operation of the Trans-Gabonese railway, which transported manganese ore from the mine at Moanda to the port at Owenda, and announced plans to build a \$77 million (French franc 470 million) manganese ore enrichment and sintering plant in Gabon. The plant, to be built at Moanda, will have a production capacity of 600,000 t/yr of sintered manganese ore. The new plant will extend the life of the mine by allowing the processing of manganese fines and will provide a direct feed to Eramet's ferroalloy plants. The 3-year development project will be operational in 2001 (Eramet Group, April 7, 1999, Annual report of the Eramet Group for 1998, accessed November 11, 1999, at URL <http://www.eramet>).

Uranium.—The uranium mine at Mounana in Haut Ogooué Province was nearing depletion, and Compagnie des Mines d'Uranium de Franceville (COMUF) planned to close it in May 1999. COMUF produced 862 metric tons of uranium oxide in 1998, its last full year of operations and its highest production since 1989. COMUF was controlled by Compagnie Generale des Matieres Nucleaires of France (39%) and the Government of Gabon (29.4%).

Industrial Minerals

Increased spending on infrastructure projects has increased the demand for cement to a rate of about 220,000 t/yr, with most of the demand met from local production. Domestic plants included the 300,000 t/yr clinker manufacturing plant near Libreville, owned by Cimenterie de N'Toum; grinding plants at Owendo and Franceville each have the capacity to produce 150,000 t/yr of cement (International Cement Review, 1998).

Fuels

Petroleum was produced by three companies, in order of decreasing output—Shell Gabon of the Netherlands, Elf Gabon of France, and Perenco Plc of the United Kingdom. During 1998, Marathon Petroleum Gabon LDC of the United States began production from the new offshore Tchatamba Marin oilfield, and Ocelot Energy Inc. of Canada, from the Obangue Field. The Government hoped to use the success of deepwater petroleum exploration in nearby Angolan and Nigerian waters to attract more exploration activity to Gabon. Initial interest was being shown by Chevron Corp. of the United States, Elf Aquitaine, and Total S.A. of France. Other petroleum exploration companies from Canada, Italy, South Africa, and the United States were also active. The U.S. Energy Information Administration noted on its web site that although

Gabon's proved oil reserves had increased from 1.3 billion barrels in 1996 to 2.5 billion barrels in 1997 and 1998, the Government was concerned about the longer term trend of declining oil reserves and about declining production from some of the older, established fields (U.S. Energy Information Agency, March 1999, Country analysis brief—Gabon, accessed December 12, 1999, at URL <http://eia.doe.gov/emeu/cabs/gabon.html>).

Outlook

A more detailed discussion of recent developments in the oil industry of Gabon is also available through the U.S. Energy Information Administration. Although Gabon withdrew its membership in the Organization of Petroleum Exporting Countries in 1996, its petroleum production remained level at around 362,000 barrels per day in 1998.

The outlook for the future of minerals development in Gabon is modest and contingent on future market conditions and exploration successes. The economy is likely to be dominated by the petroleum sector for the foreseeable future, with the focus of new exploration on deepwater basins. Although uranium mining is phasing out, the potential for new developments in columbium (niobium), manganese, and possibly phosphate suggests a continued role for mining in the economy. The lack of adequate infrastructure in many areas of the country inhibits new grassroots exploration and remains a major cost constraint on development of the well-defined iron ore deposit at Belinga.

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TABLE 1
GABON: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity 2/	1994	1995	1996	1997 e/	1998 e/
Cement:					
Cement, hydraulic 3/	147,798 r/	153,953 r/	185,000 r/	200,000	196,000
Clinker	124,600 r/	132,398 r/	162,000 r/	176,000	180,000
Diamond, gem and industrial e/	500	500	500	500	500
Gas, natural, gross	129	150	100 r/	99	99
Gold, mine output, Au content e/ 4/	72	70	70	70	70
Manganese:					
Metallurgical-grade ore, gross weight (50% to 53% Mn) 5/					
thousand metric tons	1,366 e/	1,844	1,933	1,860	2,044
Pellets, battery- and chemical-grade, gross weight (82% to 85% MnO ₂)	70 e/	86	50	44	48
Total 5/	1,436	1,930	1,983	1,904 6/	2,092 6/
Petroleum:					
Crude	126,000	133,000	134,000	134,000	132,000
Refinery products	6,900	5,466 r/	6,043 r/	6,315 6/	6,200 6/
Uranium, content of concentrate	589	653	623	472 6/	862 6/

e/ Estimated. r/ Revised.

1/ Table includes data available through December 1999.

2/ In addition to the commodities listed, a variety of crude construction materials (clays, sand and gravel, and stone) is also produced, but output is not reported, and available information is inadequate to make reliable estimates of output levels.

3/ Includes cement produced from imported clinker.

4/ Gold production figures do not include production smuggled out of the country, which in recent years was estimated to exceed 400 kilograms per year.

5/ Data are rounded to four significant digits.

6/ Reported figure.

TABLE 2
GABON: STRUCTURE OF THE MINERAL INDUSTRY IN 1998

(Thousand metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
Cement:				
Cement, hydraulic		Société des Ciments du Gabon (Government, 91.4%; Elf Gabon, 8.6%)	Clinker-grinding plant at Owendo	270
Do.		do.	Clinker-grinding plant at Franceville	130
Clinker		do.	Clinker plant at N'Toum, 40 kilometers east of Libreville	350
Manganese, ore		Compagnie Minière de l'Ogooué (Eramet, 61%; Government, 28%.)	Open pit mine at Moanda	2,600
Petroleum, crude	thousand 42-gallon barrels	Elf Gabon (Société Nationale Elf Aquitaine 75%; Government, 25%)	Anguille, Barbier, Baudroie, Brème, Gonelle, Grondin Marine, Mandaros, and Torpille offshore fields	30,000
Do.	do.	do.	Avocette, Coucal, and Hylia fields	25,000
Do.	do.	Shell Gabon (Royal Dutch-Shell, 75%; Government, 25%), 42.5% interest in field	Rabi Kounga field, 100 kilometers north of Gamba	75,000
Do.	do.	do.	Gamba-Ivinga field, onshore Gamba	4,000
Do.	do.	Perenco Plc., 45% interest in field	Oguendjo offshore field, 85 kilometers south-east of Port Gentil	3,000
Do.	do.	Perenco Plc., 75%, and Government, 25%, joint venture	Lucina Marine offshore field, 15 kilometers south of Mayumba	2,000
Do.	do.	Perenco Plc., 50%, and London and Scottish Marine, 50%, joint venture	Obando, Octopus, and Pelican offshore fields, 60 kilometers southwest of Port Gentil	5,000
Petroleum products	do.	Société Gabonaise de Raffinage (Government, 25%; Elf Gabon, 18.7%; Total, 18.7%; Agip, 6.2%; BP, 6.2%; Fina, 6.2%; Mobil, 6.2%; Shell, 6.2%; and Texaco, 6.2%)	Refinery at Port Gentil	8,760
Uranium, oxide (metal content)	metric tons	Compagnie des Mines d'Uranium de Franceville (Compagnie Francais de Mokta, 39.2%; Compagnie Générale des Matières Nucléaires, 18.8%; Government, 24.7%; Minatom, 13%; and others, 4.3%)	Two mines near Mounana (closing mid-1999)	1,500

THE MINERAL INDUSTRY OF

THE GAMBIA

By Philip M. Mobbs

The Gambian economy was dominated by agriculture and tourism. The mineral industry was a minor component of the national economy, with production of clays for brick, laterite, sand and gravel, and silica sand.

In 1997, Interbulk of Switzerland, a subsidiary of the Italcementi Group of Italy, completed a cement import terminal in Banjul. In 1998, the Government received the results of a Chinese mineral survey that documented a deposit of 40 million metric tons of silica sand, in addition to known resources of 660,700 metric tons (t) of ilmenite and 135,200 t of zircon, at a 1% cutoff grade (Carnegie Minerals NL, April 7, 1999, Large licence, measured resources plus exploration potential in The Gambia, accessed April 21, 1999, at URL http://www.ozemail.com.au/~harburn/ann07_04.htm).

During 1998, West Oil NL of Australia and Fusion Investments Ltd. of the United Kingdom signed a technical cooperation agreement to evaluate The Gambia's offshore

prospects. In June, the joint venture of Planet Oil Holdings Ltd. of the United Kingdom (90%) and Balmain Resources Pty. Ltd. of Australia (10%) acquired a 1-year production-sharing contract for offshore block PPL-98E. Planet Oil was subsequently acquired by Hardman Resources NL of Australia.

For more extensive coverage of the mineral industry of The Gambia, see the 1991 Minerals Yearbook, Volume III, Mineral Industries of Africa, page 227.

Major Source of Information

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TABLE 1
THE GAMBIA: PRODUCTION OF MINERAL COMMODITIES 1/ 2/

(Metric tons)

Commodity	1994	1995	1996	1997	1998
Clay	1,000 e/	1,000 e/	1,000	1,200	1,200
Silica sand	450,000 e/	450,000 e/	452,400	302,600	269,773

e/ Estimated.

1/ Includes data available through August 3, 1999.

2/ In addition to the commodities listed, a variety of construction materials (laterite, sand, and shell) are produced; but information is inadequate to make estimates of output.

THE MINERAL INDUSTRY OF

GHANA

By George J. Coakley

Ghana is a West African country with an area of 238,540 square kilometers, a 1998 population of around 19 million, and a per capita gross domestic product of about \$378.¹ Its economic growth rate was 4.6%, led by, in order of value, gold, cocoa, and timber production. The impact of a domestic energy crisis was shown in the drop in the rate of growth of the industrial sector of the economy to 2.5% from 6.4% in 1997. The growth rate of the mining and quarrying subsector also declined to 4.0% from the 5.6% level of 1997 (Ghana Ministry of Finance, 1999, Budget review—GDP growth rises by 4.6 percent, accessed September 30, 1999, at URL <http://www.ghanaweb.com/GhanaHomePage/ghana/news/ECONS/budget1.html>). Ghana was the second largest gold producer in Africa, after South Africa. It also was the third largest African producer of aluminum metal and manganese ore and a significant producer of bauxite and diamond. With contributions from three new mines at Bibiani, Damang, and Tarkwa, gold production increased by 33% to 72.5 metric tons (t).

Government Policies and Programs

Legislation affecting mining and mineral exploration in Ghana includes the Minerals and Mining Law 1986 (PNDCL 153); the Additional Profits Tax Law, 1985 (PNDCL 122); the Minerals Commission Law, 1986 (PNDCL 154); and the Minerals (Royalties) Regulations, 1987 (LI 1349). The 1986 mining law had been instrumental in attracting more than \$3 billion in foreign investment in Ghanaian mining industry through the end of 1997. The Petroleum (Exploration and Production) Law, 1984 (PNDCL 84), sets out the policy framework and describes the role of institutional participants, namely the Ministry of Energy and Mines, which regulates the industry, and the Ghana National Petroleum Corporation (GNPC), which is empowered to undertake petroleum exploration and production on behalf of the Government. The GNPC was established under the Ghana National Petroleum Corporation Law of 1983 (PNDCL 64) and is authorized to enter joint ventures and production-sharing agreements with commercial organizations. The regulation of artisanal gold mining is set forth in the Small-Scale Gold Mining Law, 1989 (PNDCL 218). The Precious Minerals Marketing Corporation Law, 1989 (PNDCL 219), set up the Precious Minerals Marketing Corp. (PMMC) to promote the development of small-scale gold and diamond mining in Ghana and to purchase the output of such mining, either directly or through licensed

buyers. The Minerals and Mining (Amendment) Act of 1994 reduced the 45% general mining corporate tax rate to 35%, the same as that imposed on other industries.

The Ministry of Lands and Natural Resources oversees all aspects of the Ghanaian mineral economy and is the grantor of mineral exploration and mining leases. Within the Ministry, the Minerals Commission has responsibility for recommending mineral policy, promoting mineral development, advising the Government on mineral matters, and serving as a liaison between industry and the Government. The Ghana Geological Survey Department conducts geologic studies; the Lands Commission maintains records of exploration licenses and mining leases; and the Mines Department has authority in mine safety matters. All mine accidents and other safety problems also must be reported to the Ghana Chamber of Mines, the private association of operating mining companies. The Chamber also provides information on Ghana's mining laws to the public and negotiates with the mine labor unions on behalf of its member companies. The Ministry of Fuel and Power formulates Ghanaian energy policy and issues licenses for onshore and offshore petroleum and natural gas exploration.

Environmental Issues

Mining and the associated growth of communities has led to locally severe deforestation, erosion, and water pollution. Where sulfide gold ores have been roasted, there has been air pollution from sulfur and arsenic gas emissions. Ashanti Goldfields Co. Ltd. used an arsenic recovery circuit in its gold roasting plant at Obuasi. Mercury was widely used to amalgamate gold by artisanal miners in Ghana. Artisanal usage in particular has led to mercury contamination of rivers. The Environmental Protection Agency was established in 1994. All new mining operations will be required to conduct and submit environmental impact studies and to plan their operations to minimize environmental damage. Similarly, rehabilitation of existing mines will include environmental planning. A portion of mining royalties will be directed to an environmental remediation fund, particularly to address problems in the artisanal sector.

Production

As shown in table 1, production levels of Ghana's major mineral commodities were mixed in 1998. In addition to the expansion in gold production, manganese output increased by 23% over 1997. Aluminum, bauxite, and diamond production levels decreased by 63%, 12%, and 3%, respectively, from those of 1997. Power supply problems continued to beleaguer the Volta Aluminum Co. Ltd.'s (VALCO) aluminum smelter, which operated at less than 25% of capacity in 1998. Reported sales of

¹Where necessary, currency values have been converted from Ghanaian cedis (C) to U.S. dollars at the rate of C2,417=US\$1.00 for 1998 and C2,050=US\$1.00 for 1997.

artisanal gold production to the PMMC declined by 44% in 1998 over those of 1997. An unknown quantity of artisanal gold production was, however, undocumented owing to theft, internal consumption for jewelry and traditional gold ceremonial artifacts, or alleged smuggling into Cote d'Ivoire or Togo where the French West African franc was more convertible. Data were lacking for this commerce, and estimates of its magnitude are not included in table 1. Cement and steel were the main mineral commodities produced chiefly for local consumption.

Trade

Virtually all Ghana's primary mineral production was exported, as was much of its secondary, or value-added, mineral output. According to the Ministry of Finance, gold export earnings increased to \$687.8 million compared with \$646.7 million in 1997, accounting for 37.6% of total exports of \$1.83 billion in 1998 (Ghana Ministry of Finance, 1999, Ghana budget, accessed August 30, 1999, at URL <http://www.finance.gov.gh/budget/index.html>). In 1998, the value of all primary mineral commodity exports was estimated to be around \$793 million, or about 46% of total exports. Ghana's main processed mineral commodity export was aluminum, which was toll refined in Ghana from imported alumina. On the basis of the average price of aluminum of \$0.65 per pound in 1998, aluminum production of 56,000 t was valued at about \$80 million. The Ghana Chamber of Mines reported that the total value of mined product sales, which approximate export sales, by member companies, was \$712.6 million in 1998. Gold sales were valued at \$679.4 million; diamond, at \$15 million; manganese ore, at \$11 million; and bauxite ore, at \$7.2 million (Ghana Chamber of Mines, 1999).

Ghana's mineral commodity imports were dominated by alumina, fertilizers, clinker for cement, and petroleum products. The value of these imports was not available but were estimated, on the basis of previous years, to range between \$300 million to \$400 million per year. Data on imports of mine and mill equipment, explosives, and reagents, such as sodium cyanide, were unavailable, but given the level of gold production and new mine developments, the value probably exceeded \$250 million per year.

Structure of the Mineral Industry

Through privatization programs, the Government greatly reduced its once-dominant stake in the cement and gold industries but has maintained a controlling interest in Ghana Consolidated Diamonds Ltd., the GNPC, and the state-run Steelworks Co.

Efforts to attract foreign investment in recent years have brought in a wide range of companies from Australia, Canada, South Africa, the United Kingdom, and the United States that now hold controlling interests in most of the current mines in Ghana. (See table 2.) In addition, more than 100 exploration licenses were held by foreign companies; however, the level of active exploration began to drop in 1998, in part owing to the decrease in exploration risk capital from Canada. The American company, Kaiser Aluminum Corp., maintained a longstanding 90% interest in the VALCO aluminum smelter.

Commodity Review

Metals

Aluminum and Bauxite.—The VALCO smelter, Ghana's sole producer of aluminum, continued to be affected by drought-induced power disruptions and rationing and operated at less than 25% of capacity in 1998. The smelter at Tema Harbor used prebake technology and toll-processed imported alumina supplied by Kaiser and its minority shareholder, Reynolds Aluminum Co., into primary aluminum. Long-term tolling contracts provide for proportionate payments by the participants in amounts intended to pay not less than all VALCO's operating and financing costs. The company's share of the primary aluminum is sold to third parties. During most of 1998, the VALCO smelter operated only one of its five potlines compared with 1997 when VALCO operated four potlines. Each of VALCO's potlines produced approximately 40,000 metric tons per year of primary aluminum. VALCO received compensation, in the form of energy credits to be used during the last half of 1998 and during 1999, from the Volta River Authority (VRA) in lieu of the power necessary to run two of the potlines that were curtailed during 1998, although VALCO continued to seek compensation from the VRA with respect to the January 1998 reduction of its power allocation. On the basis of VALCO's proposed 1999 power allocation from the VRA, VALCO announced that it expected to operate three lines during 1999. The decision to operate at that level was also based on consideration of market and other factors (Kaiser Aluminum Corp., 1999, Annual report, Form 10-K, 1998, U.S. Securities and Exchange Commission, accessed October 12, 1999, at URL <http://www.sec.gov/Archives/edgar/data/811596/0000811596-99-000004.txt>).

Ghana Bauxite Co. Ltd. (GBC) operated the country's only bauxite mine at Awaso. In March 1998, Alcan Aluminum Ltd. of Canada increased its equity position in GBC from 45% to 80% and was pursuing an initiative to expand mine capacity (Alcan Aluminum Ltd., 1999, Annual report for 1998, accessed September 28, 1999, at URL <http://www.alcan.com/AnnualRp.nsf/webpages-E/product-review>). In 1998, GBC shipped more than 400,000 t of chemical grade bauxite ore to captive alumina plants—most to the Burntisland plant in Fife, Scotland, and lesser amounts to plants in Jonquiere, Quebec, and Aughinish, Ireland.

Gold.—Of the 18 gold mines in operation in Ghana in 1998, 4 accounted for a total of 70% of the recorded gold output of the country. These four mines were the Obuasi (38.0%), the Damang (11.6%), the Teberebie (10.9%), and the Obotan (7.5%). A breakdown of gold production, by mine, for 1994 through 1998 is shown in table 3.

Ashanti's corporate gold production for 1998 from mines in Ghana, Guinea, and Zimbabwe was 48,136 kilograms (kg), of which approximately 81% came from operations in Ghana. AGC also maintained active exploration programs in Botswana, Burkina Faso, Mali, Mozambique, Senegal, Tanzania, and Zambia; the Geita gold project in Tanzania was scheduled for development by 2000.

The Ashanti mining complex at Obuasi, Ghana, one of the richest gold mines in the world, increased overall production by

3% in 1998 to 27,537 kg. The mine exploits quartz and sulfide ores from a steeply dipping vein and shear zone system in lower Proterozoic greenstones of the Birimian Series. Gold ore grades had averaged about 20 grams per metric ton (g/t) of gold for much of the mine's century-long history but have declined to around 7 g/t in recent years as the ratio of quartz to sulfide ore from underground workings has decreased and as large quantities of lower grade ores from surface workings and tailings have begun to be mined and remined. As reported in the Ashanti annual report for the calendar year ending December 31, 1998, the Obuasi underground mine delivered 2.24 million metric tons (Mt) of ore to the mill with an average grade of 8.57 g/t compared with 1.93 Mt of ore with an average grade of 8.48 g/t in 1997. The increase in underground productivity was a result of the mine expansion and mechanization program begun in 1993, which culminated in the commissioning of the Kwesi Renner Shaft in July 1998, providing an additional 1 million metric tons per year (Mt/yr) of hoisting capacity. At the Obuasi surface mine operations, 29.8 Mt of waste overburden was stripped, and 4.32 Mt of ore grading 3.22 g/t was mined compared with ore production of 3.99 Mt grading 3.06 g/t in 1997. Operations at the Sansu pit, one of four surface oxide deposits being mined, ended in November 1998.

The Obuasi ore was processed at four treatment plants and a heap-leach operation. The Sansu sulfide treatment plant (STP) was the world's largest bio-oxidation (BIOX) gold treatment facility. The STP treated 2.60 Mt of ore grading 5.29 g/t in 1998 compared with 2.49 t of the same grade ore in 1997. It had a gold recovery rate of 78.8% and contributed 10,823 kg, or 39% of total Obuasi gold production in 1998.

Ashanti's Pompora treatment plant processed 1.75 Mt of ore with an average grade of 8.65 g/t yielding 12,379 kg of gold at a recovery rate of 81.8%. At the oxide treatment plant, 2.29 Mt of material were processed grading 1.74 g/t yielding 2,706 kg of gold at a recovery rate of 68.2%. The tailings treatment plant processed 1.85 Mt of ore grading 2.61 g/t yielding 1,538 kg of gold at a recovery rate of 31.9% in 1998. A small heap-leach plant stacked 217,000 t of ore grading 0.71 g/t and recovered 73 kg of gold.

At Ashanti's three other Ghanaian mines, the Bibiani mine and carbon-in-leach (CIL) plant, which were commissioned in the first quarter of 1998, were operating near its full annual capacity of 6,840 kg of gold by yearend; the economic reserves at Iduapriem were expected to be depleted by the end of 1999; and at Ayanfuri, heap-leach ore stacking was increased from 1 to 1.3 Mt/yr to compensate for declining ore grades. Operations at Ayanfuri after 2000 will be dependent on the success of ongoing exploration in the area.

At the end of 1998, Ashanti reported measured and indicated resources of 63.9 Mt at an average grade of 10.2 g/t containing 727,800 kg of gold at Obuasi, of which 41.7 Mt of underground reserves grading 9.2 g/t of gold will be the focus of future production. Measured and indicated gold resources at other mines included 21.7 Mt grading 2.7 g/t at Bibiani, 20.9 Mt grading 1.5 g/t at Iduapriem, and 3.4 Mt grading 1.5 g/t at Ayanfuri. Contained within these resources, Ashanti reported proven and probable ore reserves as of December 31, 1998, on the basis of a gold price of \$300 per ounce, of 55.7 Mt at a grade of 7.6 g/t containing more than 426,000 kg of gold at

Obuasi, 16.4 Mt at a grade of 2.7 g/t at Bibiani, 6.2 Mt grading 1.1 g/t at Iduapriem, and 1.8 Mt grading 1.8 g/t at Ayanfuri (Ashanti Goldfields Co. Ltd., 1999). Ashanti acquired the 50.4% equity interest in Prestea Sankofa Gold Ltd. previously held by SAMAX Gold Inc. of the United Kingdom (50.4%) when Ashanti purchased Samax and its Ghanaian and Tanzanian gold properties for \$135 million in late 1998. Other partners in the Prestea Sankofa joint venture were the GNPC (39.6%), and the Government (10%). The joint venture had been granted an 8-year lease in early 1994 to recover gold from the old Prestea Mine tailings and dumps. A 320,000-metric-ton-per-year CIL plant commissioned in May 1995 was to produce up to 680 kilograms per year (kg/yr) from an initial total of 1.8 Mt of old Prestea calcines, tailings, and mine waste for at least 7 years.

Gold Fields (Ghana) Ltd.'s major new Tarkwa surface mine started production in April 1998, milling 3.05 Mt of ore, grading 1.18 g/t, and yielding 2,522 kg of gold during its first year of operation. The \$125 million Tarkwa open pit, heap-leach project, which involved the relocation of more than 20,000 Ghanaian villagers, will produce 7,775 kg/yr of gold by 2000, with plans to double production to 15,550 kg/yr of gold. Gold Fields also produced 1,670 kg of gold from 227,864 t of ore milled grading 1.46 g/t from the old, 1,000-meter deep underground workings in 1998. The company reported reserves and resources at Tarkwa, as of June 30, 1998, using a gold price of \$290 per troy ounce as follows. The underground workings contained a measured and indicated ore resource of 541,927 t grading 6.4 g/t of gold, of which proven and probable ore reserves were 178,801 t grading 13.7 g/t. In situ, near surface resources at Tarkwa are located in seven deposits containing a total of 298 Mt at an average grade of 1.40 g/t for a total resource of 13 million troy ounces (429,542 kg) of contained gold, one of the largest gold deposits outlined in the world in recent years. The mineralization occurs within a quartz pebble "Banket" conglomerate of the upper Tarkwaian Group, similar in characteristics to the Witwatersrand goldfields of South Africa. The two largest deposits, the Akontasi Ridge and the Pepe open pit, contained resources of 87.7 Mt grading 1.2 g/t and 67.8 Mt grading 1.5 g/t, respectively. The other deposits were, in descending gold content, Akontasi East, Kottraverchy, Mantraim, Pepe West Underlap, and Pepe N&S. Minalable reserves at the new Tarkwa mine were reported to be 157.2 Mt grading 1.35 g/t (Ghana Chamber of Mines, 1999; Gold Fields Limited, 1998, Gencor/Gold Fields of South Africa merger prelisting statements—3. Geology and resource/reserve estimates, accessed November 13, 1998, at URL <http://www.goldfields.co.za/prelist/prlst12.htm>).

Abosso Goldfields Ltd., owned by Ranger Minerals Ltd. of Australia, began first production of gold at its new \$135 million Damang gold mine, located 30 kilometers (km) northeast of Tarkwa, in November 1997; plant commissioning continued through December 1997. During its first full year of operations in 1998, 3.99 million cubic meters (Mm³) of ore and 6.32 Mm³ of waste were removed to produce 8,421 kg of gold. The project was based on mineral resources, based on a cutoff grade of 1.0 g/t of gold, as of December 31, 1998, of 15 Mt measured grading 2.22 g/t; 26.3 Mt indicated grading 2.03 g/t; and 18.7 Mt inferred grading 2.06 g/t for a total resource of 60 Mt at an average grade of 2.09 g/t containing more than 4 million troy ounces (125,409 kg) of gold (Ranger Minerals Ltd., 1999,

Damang Resource estimate as at 31 December 1998, accessed September 11, 1999, at URL <http://www.ranger.com.au/operations.htm>). Mining at Damang, during an 8-year mine life will be at rate of 4 to 4.5 Mt/yr of ore, with an annual production of more than 10,000 kg of gold, based on an expected recovery of 94% from a standard CIL plant. The CIL plant constructed by Minproc Engineers Ltd. of Australia consisted of a gyratory crusher, a primary high lift semiautogenous (SAG) mill in closed circuit with a pebble mill and a secondary ball mill, gravity concentration, a six-stage CIL leach-adsorption circuit, and an Anglo desorption plant. Capital costs included diversion of five watercourses draining away from the mine into the Bonsa River, a 6.6-km deviation of the Accra-Takoradi railway line, the resettlement and establishment of a new townsite for Damang, and a 25-km-long powerline linked to the national grid. In July, Ranger spent an additional \$7.5 million to install a 17-megawatt (MW) powerplant at Damang to enable it to maintain operations during power shortages on the national grid.

Teberebie Goldfields Ltd. (TGL), owned by the Pioneer Group Inc. of the United States, operated the Teberebie Mine, 6 km south of Tarkwa. The TGL open pit heap-leach operation extracted ore from the Teberebie/Awunaben and the Mantraim pits. Teberebie gold output decreased by 4% to 7,877 kg in 1998. The decline was attributed to reduced heap-leach recoveries from the harder, less weathered ore that was being treated. The harder ore being mined will require a transition from heap leaching to bulk mining and conventional milling and will likely reduce the minable portion of the 183,500 kg of in situ reserves reported previously by the company. The \$57 million Phase III expansion of Teberebie was completed by the end of 1997, expanding ore processing capacity to 12 Mt/yr by adding a new heap-leach operation, a third gyratory crusher, and a new South plant and by adding a second carbon absorption train to the absorbition desorbition refinery (ADR) plant. The Pioneer Group announced its plans to offer TGL for sale in 1999 (Pioneer Group Inc., 1999, Annual Pioneer Group Inc. report and form 10-K—1998; U.S. Securities and Exchange Commission, accessed October 12, 1999, at URL <http://www.sec.gov/Archives/edgar/data/733060/0000950135-99-001704.txt>).

Resolute Amansie Ltd. poured the first gold at its \$32 million Obotan gold project in May 1997. The project included two open pits, a gold-treatment plant with a single-stage crushing circuit and semiautogenous grinding mill, seven CIL tanks, and a 5-t gold circuit. In its first full year of operation, Obotan produced 5,411 kg of gold from 2.28 Mt of ore processed. For the quarter ending December 31, 1998, head grades at Obotan averaged 2.32 g/t with a 92.2% recovery. Recovery rates were dropping as mining at the Nkran Hill open pit moved into harder ore with a higher sulfide content (Resolute Ltd., 1999, Report on activities for the quarter ending 31 December 1998, accessed May 10, 1999, at URL <http://resolute-ltd.com.au/sc14-qreport/pdfs/December%20Quarterly%201998.htm>). The Obotan project, 40 km northwest of Obuasi, included the Nkran Hill and the Adubiaso Hill surface deposits. Production was expected to average 4,665 kg/yr of gold during its 10-year mine life. Mine development was based on total resources of 21.9 Mt at a grade of 1.95 g/t of gold, including reserves of 10.15 Mt grading 2.12 g/t (Resolute Limited, 1997, Annual Resolute

Limited report, 1996, accessed February 3, 1998, at URL <http://resolute-ltd.com.au>). In 1998, Resolute reported 900,000 troy ounces (28,000 kg) of contained gold reserves and an additional 1.3 million troy ounces (40,400 kg) of gold resources with exploration activities focused on identifying additional nearby oxide reserves and on defining the potential for future high-grade underground mining (Resolute Ltd., 1998, Obotan gold project—Ghana, accessed July 7, 1998, at URL <http://resolute-ltd.com.au/sc10-gold/html/10obotan.html>).

Satellite Goldfields Ltd., controlled by Glencar Explorations Plc. of Ireland, completed development of its \$42.5 million Wassa project, about 35 km northeast of Tarkwa, during 1998 with the first gold pour taking place on January 23, 1999. Development costs included the purchase of five 1,250-kilovolt-ampere generator sets, which will insulate the mine from national power shortages. The 3-Mt/yr open pit and heap-leach operation was expected to produce at a rate of 4,043 kg/yr. More than 390,000 t of run-of-mine ore had been mined, and 232,000 t, grading 1.64% gold, had been stacked during 1998 in anticipation of startup. The ore was crushed, agglomerated with cement, stacked, and leached on a 90-day recovery cycle. Gold was recovered from leach solutions in an on-site ADR plant. The Wassa deposit is within Lower Birimian greenstones, felsic volcanics, and a distinctive ironstone formation. Vein and stockwork mineralization occurs in the felsic and phyllitic lithologies. Mining is based on a reserve of 23 Mt at a grade of 1.4 g/t gold with an ongoing exploration program around the mine designed to expand the known reserves. The minable reserves at Wassa represented about 50% of the known resource base. Glencar, with its joint-venture partner, Moydow Limited, was also exploring the Kanyankaw and Asheba concessions south of Tarkwa (Glencar Explorations Plc., 1999).

Bogoso Gold Ltd. operated the Bogosu mine in the Western Region, processing 2.03 Mt of ore yielding 3,813 kg of gold in 1998. While the company was working on an oxide reserve base, it had on-site processing facilities for sulfide ores, consisting of flotation, roaster, and CIL circuits. The company reported proven and probable oxide ore reserves, as of March 31, 1999, of 1.96 Mt of ore grading 2.6 g/t gold. These ore reserves were contained within measured and indicated mineral resources, which included 2.87 Mt of oxidized material grading 2.3 g/t gold, 3.2 Mt of transitional mineralization grading 2.8 g/t, and 10.3 Mt of sulfide material grading 3.3 g/t gold (Ghana Chamber of Mines, 1999). Work done by the previous owner Billiton plc. (formerly Gencor Limited of South Africa) indicated that the metallurgically complex sulfide ores on the property were technically amenable to mining and treatment by flotation, BIOX, and cyanidation (Gencor Limited, 1996).

Barnato Exploration Ltd. (Barnex), a subsidiary of JCI Ltd. of South Africa, ceased mining the Prestea underground workings in August 1998 after 70 years of operation. Former employees announced their intentions to buy the underground mine and to operate it under the umbrella of Prestea Gold Resources Ltd. (Mining Journal, 1998b). The 3.8 billion cedis (\$1.6 million) used to acquire the underground mine represented the severance awards payable to the 1,712-person workforce by Barnex (Ghana Daily Graphic, 1998, Ex-Barnex workers set to acquire company, accessed December 7, 1998, at URL <http://graphic.com.gh/dgraphic/news/ex5.htm>). Exploration by Barnex around Prestea identified a near-surface resource of 4.68

million troy ounces (145,656 kg) of gold. Prestea Gold was conducting a feasibility study on developing an open pit mining operation on the property (African Mining Bulletin, 1998).

Bonte Gold Mines Ltd., owned by Akrokeri-Ashanti Gold Mines Inc. of Canada, treated 1.06 Mm³ of material yielding 1,093 kg of gold in 1998 from the small alluvial mining operation on the Esaase concession. Remaining ore reserves, as of December 1998, were reported to be 5,392 kg of contained gold (Ghana Chamber of Mines, 1999). Akrokeri-Ashanti also acquired an 85% interest in the Goldenrae alluvial mine from the Netherlands Development Finance Co. The company planned on reopening Goldenrae in mid-1999, with production planned at 871 kg/yr of gold from a plant with the capacity to process 150 cubic meters per hour of alluvial material (Mining Journal, 1998a).

Active exploration for gold by companies from Australia, Canada, Europe, Ghana, South Africa, and the United States continued in 1998. Advanced stage exploration projects included the Gold Fields Limited's Centenary gold mining project, where a feasibility study was initiated in 1998 on the basis of a reported 43,545-kg gold reserve estimate (Gold Fields Limited, 1998, Orogen—Centenary Gold Mining Project, accessed November 13, 1998, at <http://www.goldfields.co.za/ops/orogen.htm>); Birim Goldfields Inc. of Canada was exploring the Mampon and Aboronye zones of its Dunkwa license in joint venture with Battle Mountain Gold Co. of the United States and its Bui Area Licenses in joint venture with Dominion Mining Ltd. of Australia; St. Jude Resources Ltd. of Canada continued drilling of the Adoikrom, Dabrokrom, Father Brown, and Seikrom mineralized zones of its Hwini-Butre Concession.

Other exploration programs included Shiega Resources Corp. of Canada (formerly Alpine Exploration Corp.), which acquired Union Mining Ltd. of Ireland's Karemenga and Shiega gold prospects near Bolgatanga in northern Ghana and was working the Nkroful mining lease, 80 km west of Takoradi, in joint venture with Ashanti and the adjacent Ebi/Teleku Bokazo license in joint venture with SEMAFO Inc. of Canada. SEMAFO had reported drill-indicated resources at Teleku Bokazo of 1.7 Mt of oxide ore grading 2.6 g/t and 1.1 Mt of sulfide ore grading 3.1 g/t (Shiega Resources Corp., July 6, 1998, Extension of Nkroful agreement with SAMAX Gold and participation in new agreement with SEMAFO, press release, accessed July 7, 1998, at URL <http://biz.yahoo.com/pmnews/980706/shiega-agr-1.html>). Red Back Mining NL of Australia was exploring the Chirano gold property, adjacent to the Bibiani Mine, in joint venture with Reunion Mining plc of the United Kingdom. Kenor ASA of Norway was pursuing four gold geochemical anomalies on the Wa license in northern Ghana; and Leo Shield Exploration NL of Australia had identified gold resources of 11,570 kg and 5,600 kg, respectively, at its Manso Nkwanta and Ashanti Reconnaissance projects (Leo Shield Exploration NL, 1999, West African Gold exploration, accessed October 24, at URL <http://leoshield.com.au>). Resolute Ltd. established a joint venture with BHP World Minerals Ltd. of Australia on 16 concessions in Ghana and 4 adjacent countries. Carlin Resources Corp. and EXP Resources Ltd. of Canada were jointly exploring the Chichiwere property, 40 km northeast of the Bibiani Mine, and the Canadian joint venture of African Selection Mining Corp. and Golden Eagle Mining Ltd. were

drilling on the Grupe license in northern Ghana. Nevsun Resources Ltd. of Canada reported a gold resource of 3.63 Mt of primary ore grading 3.63 g/t and 1.64 Mt of oxide ore grading 1.64 g/t at its Kubi property on the basis of exploration through November 1998 (Nevsun Resources, November 18, 1998, Update on the Kubi property—Ghana, press release, accessed November 19, 1998, at URL <http://biz.yahoo.com/bw/981118/nevsun-1.html>).

Manganese.—Ghana Manganese Company Limited's Nsuta-Wassaw open pit mine, which was privatized in 1995, was the only significant producer of manganese ore in Ghana. The mine produced manganese oxide and carbonate ores, as well as a transitional ore referred to as "Carbox." Most of the carbonate ores at the Nsuta Mine had been depleted, and exploration aimed at expanding manganese resources on adjacent hills was ongoing. Total production of manganese ore in 1998 was 536,871 wet metric tons of run-of-mine ore with 390,156 dry metric tons exported. Except for a few hundred tons of battery-grade oxide ore sold to local battery companies and very small amounts sold to gold-processing plants, the mine's ore sales were exports.

Industrial Minerals

Ghana Consolidated Diamonds' Akwatia diamond mine was the only operating diamond mine in Ghana in 1998. A total of 252,377 carats were recovered from 375,000 cubic meters of ground mined. Akwatia also produced 24 kg of gold as a byproduct. The Akwatia production in 1998 had a value of \$17.60 per carat of diamond exported. Apart from Akwatia, diamond production in Ghana during the year was from Birim Valley artisanal workings. The true level of artisanal output was unknown because of undocumented sales and exports. In 1998, the PMMC reported purchases of 556,590 carats from artisanal and galamsey miners, with an average value of \$19.08 per carat of diamond.

Mineral Fuels

As of yearend 1998, petroleum and natural gas exploration in Ghana has been summarized by the United States Energy Information Administration (U.S. Energy Information Administration, 1999, Country Analysis Briefs—Ghana, accessed October 12, 1999, at URL <http://www.eia.doe.gov/emew/cabs/ghana.html>). Ghana's estimated 16.5 million barrels of recoverable oil reserves are located in five sedimentary basins—the Tano, the Saltpond, the Accra/Keta, the Voltaian, and the Cape Three Points. Exploration offshore Ghana began in the 1970's, and discoveries were made in waters off western Ghana (South Tano in 1978) and central Ghana (Saltpond in 1977). Phillips, the discoverer of the South Tano field, made a second find with the North Tano field in 1980. Although significant gas reserves were found in the Tano fields, Phillips deemed the finds commercially unviable and relinquished them in 1982. The GNPC, which is also responsible for the importation of crude and petroleum products, subsequently assumed operations of the Saltpond and Tano fields. In 1998, the GNPC produced an estimated 6,000 barrels per day (bbl/d) of crude oil from the Saltpond Field.

Natural gas was first discovered in the Cape Three Points Basin in 1974. The GNPC has continued exploration and appraisal on the Tano fields and has deemed that the natural gas reserves are suitable for electricity generation. Tano gas reserves were estimated to be sufficient to power a 100- to 140-MW powerplant for a period of 15 to 20 years. The Tano Fields Development and Power Project (TFDPP) was established to help meet the country's growing demand for power. The TFDPP was separated into two distinct portions—offshore field development and onshore power generation. The TFDPP's offshore portion will consist of the drilling of eight oil and gas wells on the Tano fields, installation of platforms and process facilities, construction of pipelines and hydrocarbon-gathering systems, and construction of an onshore production facility. GNPC also planned to maximize oil production of the TFDPP by using horizontal drilling technology. Total cost of the TFDPP was estimated to be \$450 million to \$500 million. Gas from reserves located in the Cape Three Points Basin or from Côte d'Ivoire's adjacent CI-01 Block would be used to meet any additional gas demand created by a possible expansion of the TFDPP's generation facilities.

Tentative plans called for Ghana to begin receiving Nigerian gas through the West African Gas Pipeline (WAGP) starting in 2001. In January 1995, the Nigerian Government first announced plans to build the WAGP, which would run from fields where gas was being flared to the neighboring countries of Benin, Togo, and Ghana. Chevron Corp. of the United States, which would supply initial deliveries of gas from its Escravos Gas Project facilities, stated that the 998-km (620-mile) WAGP would be run totally offshore, with spurs running onshore to sites in Nigeria, Benin, Togo, and Ghana. The \$400 million WAGP would have the capacity to transport more than 5 Mm³ of gas. Initial use of the gas would be to generate electricity, but plans to develop industries to use the gas were being developed. A study commissioned by Chevron indicated that between 10,000 and 20,000 primary sector jobs would be created as the new power supplies stimulated industrial growth. A feasibility study commissioned by the WAGP consortium was completed in February 1999, and construction of the WAGP was projected to begin in late 1999 or early 2000. World Bank studies showed that the countries involved in the WAGP could save approximately \$500 million in primary energy costs within 20 years. In 1998, The WAGP consortium consisted of Chevron, Shell Petroleum Development Co., Nigerian Gas Corporation, GNPC, Societe Beninoise de Gaz, and Societe Togolaise de Gaz. Chevron announced in October 1998 that it had been chosen to supply 1.13 Mm³ of gas to a 220-MW powerplant, which was under development at Tema, Ghana.

Ghana's refining facilities consist of the 45,000-bbl/d Tema Oil Refinery (TOR) outside of Accra. TOR was operated by the Tema Oil Refinery Company, a subsidiary of the GNPC. TOR primarily processed imported Bonny Light/Brass River crudes from Nigeria and a variety of refined products for domestic consumption and export. TOR's refining capacity was expanded from 25,000 bbl/d to 45,000 bbl/d in 1997, and the GNPC planned additional refinery upgrades (U.S. Energy Information Administration, 1999, Country analysis briefs—Ghana, accessed October 12, 1999, at URL <http://www.eia.doe.gov/emeu/cabs/ghana.html>).

In February 1999, the Government announced plans for a new

power system development policy to eliminate the power outages that plagued the economy in 1998. The plan called for Government involvement in joint-venture projects and expediting licensing of private-sector power projects. A major project earmarked for 1999 was the joint venture involving the Volta River Authority adding 330 MW to the Takoradi Thermal Power complex, which will be completed between 2000 and 2001. The second initiative was the GNPC project to fully commission and operate a 125-MW power barge facility and associated transmission lines under construction with funding from the Japanese Government by the end of the year. Two other projects were a joint venture involving the Electricity Corporation of Ghana to restore 80-MW generation capacity and to upgrade the distribution network within the Tema industrial estate before 2000 ends and the 220-MW independent thermal power project being sponsored by the mining companies, particularly in the bauxite, gold, limestone, and manganese industries, to assure themselves of long-term reliable power supply.

Reserves

GBC claimed that it had access to bauxite reserves at Awaso sufficient to support a mine life of 100 years; proven reserves of 29.5 Mt were reported at the end of 1994 (Ghana Chamber of Mines, 1994). As reported by the former director of the Geological Survey Department, the country has significant bauxite reserves outside the Awaso area (namely, about 60 km west of Kumasi) and those near Kibi; these have been extensively drill sampled. The deposits near Kumasi have an inventory totaling 278 Mt at a grade range of 48.9% to 51% alumina and 2.8% to 4.4% silica. The Kibi area bauxite resource totaled 120 Mt ranging in grade from 40.8% to 45.7% alumina and 1.8% to 3.9% silica (Kesse, 1985).

Ghana has large gold resources, although summation of them is complicated by the different reserve reporting methods used by various companies. Available information on reserves and resources of gold at individual mines are discussed in the gold commodity section of this report. This published data from the existing mines indicated a total defined Ghanaian resource for yearend 1998 of approximately 1,900 t (61 million troy ounces) of contained gold, of which approximately 560 t (18 million troy ounces) of gold were in the minable reserve category; the Obuasi Mine had about 38% of this resource inventory. Ghana's total gold resources are undoubtedly larger than those reported on the basis of the known extent of gold-bearing Birimian and Tarkwaian host rocks, the extent of gold mineralization reported by other ongoing grassroots exploration drilling projects; and the widespread artisanal production of gold.

The only large established manganese ore reserves in Ghana were at the Nsuta-Wassaw Mine, although several other deposits were known. As of the end of 1998, minable reserves totaled 209,000 t of manganese oxide and 9,745,000 of manganese carbonate ore (Ghana Chamber of Mines, 1999).

Ghana's large diamond resources are based on reserves at the Akwatia Mine and the widespread artisanal production of diamond. The Akwatia Mine's reserves are virtually all in river or raised terrace gravels along the Birim River. According to the company, ore reserves as of December 1998 included

119,000 cubic meters of terrace gravels and 12.1 million cubic meters of Lower and Middle Birim Valley gravels. In 1993, the average grade of Akwatia gravels had been reported at about 1.19 carats per cubic meter (Ghana Chamber of Mines, 1994, 1999). Unlike the richer diamond fields in Sierra Leone and Guinea, very few large, gem-quality stones are found at Akwatia. The departure of two potential major international mining company investors, including De Beers Consolidated Mines Ltd. (South Africa) in the early 1990's from Akwatia, however, put the economics of the deposits in question.

The U.S. Energy Information Administration reported that Ghana's recoverable oil reserves were estimated to be 16.5 million barrels and that natural gas reserves were estimated to be 2.38 billion cubic meters (840 billion cubic feet). This gas is primarily found in the Tano fields. Ghana's total gas resources, including assessments of undiscovered resource potential, were estimated to be from 44 to 59 billion cubic meters (U.S. Energy Information Administration, 1999, Country analysis briefs—Ghana, accessed October 12, 1999, at URL <http://www.eia.doe.gov/emeu/cabs/ghana.html>).

Infrastructure

The mining industry relied on a network of 953 km of railways, 39,000 km of roads, 30% of which were paved, and two main harbors at Takoradi and Tema to support mine logistics and product export. Most of the infrastructure was concentrated in the southern and southwestern parts of the country. Much of the country's road network remained in poor condition, unsuitable for transport of bulk mineral commodities. In recent years, the western railroad infrastructure has been rehabilitated to support the export of manganese and bauxite ores through Takoradi better and to provide logistical support to the major gold-producing areas. Tema, a shallow, dredged harbor near Accra, handled the needs of the VALCO aluminum smelter. Both ports handled imports of clinker for cement.

Essentially all Ghana's electrical generating capacity of approximately 6 billion kilowatthours was from hydroelectric power. Hydroelectric power was subject to the impact of periodic droughts in the region, and power disruptions and rationing were common. Electricity exports from the VRA to neighboring countries has been seriously limited since 1994.

Outlook

Fostered by a favorable political and investment climate, the prospects for continued development of the mining sector of the Ghanaian economy looked promising. Gold should continue to lead growth in the minerals sector and in the overall economy, having overtaken cocoa as the leading export. The aggressive expansion of operations by Ashanti, the post-privatization revitalization of the former state-owned mines, and the potential for ongoing exploration to add several new mines should see annual gold production approach 96,500 kg (3 million ounces) during the first decade of the third millennium. The introduction of internationally accepted environmental standards by the Government, along with the vagaries of metal commodity price cycles, may slow the rate of exploration and development. Owing to periodic droughts, domestic energy supply, especially hydroelectric power, has been a problem,

particularly for the aluminum industry and the expanding needs of the gold industry. The proposed new gas fueled power plant developments should help mitigate this problem.

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P.O. Box M 80
Accra, Ghana
Telephone: 233-21-228093
- Minerals Commission
P.O. Box M 248
Accra, Ghana
Telephone: 233-21-772-783 or 772-786
Fax: 233-21-773-324
- Mines Department
P.O. Box 3634
Accra, Ghana
Telephone: 233-21-776802
Fax: 233-31-24344 (Takoradi office)
- Ghana National Petroleum Corporation
Petroleum House
Private Mail Bag
Tema, Ghana
Telephone: 233-22-204726 or 205456
Fax: 233-22-202854 or 205449
Web site: <http://www.gnpc.com.gh>
- Ghana Chamber of Mines
P.O. Box 991
Minerals House #10
6th Senchi Street, Airport
Accra, Ghana
Telephone: 233-12-760652
Fax: 233-12-760653
E-mail: chamine@ghana.com

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- Republic of Ghana Home Page—
<http://www.ghana.com/republic>

TABLE 1
GHANA: PRODUCTION OF MINERAL COMMODITIES 1/

(Thousand metric tons unless otherwise specified)

Commodity 2/	1994	1995	1996	1997	1998 3/
Aluminum:					
Bauxite: Gross weight	426	513	473	504 3/	442
Metal, smelter, primary	141	135	137	152 3/	56
Arsenic, trioxide e/ 4/ metric tons	3,897	4,409	5,443	4,577	5,000 e/
Cement, hydraulic 5/	1,346	1,300 e/	1,500 e/	1,700 e/	2,000 e/
Diamond:					
Gem e/ thousand carats	592	506	572	664	649
Industrial e/ do.	148	126	143	166	160
Total 6/ do.	740	632	715	830	809
Gold 7/ kilograms	43,478	53,087	49,211	54,662	72,541
Manganese:					
Ore, processed	265	217	448	437	537
Mn content e/	101	82	152	140	172
Petroleum:					
Crude thousand 42-gallon barrels	--	--	2,600	2,600	2,190
Refinery products					
Liquefied petroleum gas thousand 42-gallon barrels	365	400 e/	365 r/	350 r/ e/	350 e/
Gasoline do.	1,825	1,900 e/	3,285 r/	3,300 r/ e/	3,300 e/
Jet fuel do.	365	400 e/	365 r/	350 r/ e/	350 e/
Kerosene do.	1,095	2,000 e/	1,095 r/	1,100 r/ e/	1,100 e/
Distillate fuel oil do.	1,460	1,500 e/	2,555 r/	2,500 r/ e/	2,500 e/
Residual fuel oil do.	2,190	2,200 e/	730 r/	700 r/ e/	700 e/
Other including refinery fuel and do.	365	400 e/	730 r/	700 r/ e/	700 e/
Total do.	7,665	8,800 e/	9,490 r/	9,000 r/ e/	9,000 e/
Salt e/	50	50	50	50	50
Silver, content of gold ore e/ kilograms	2,230	2,660	2,450	3,200	3,600
Steel, crude e/	25	25	25	25	25

e/ Estimated. r/ Revised.

1/ Table includes data available through June 1999.

2/ In addition to the commodities listed, a variety of crude construction materials (clays, sand and gravel, and stone) are produced, as is limestone for processing of some gold ore. Output of these commodities is not reported, and information is inadequate to make reliable estimates of output levels.

3/ Reported figure.

4/ Reported data from AGC. Bogosu roaster capable of producing arsenic before closing in 1996.

5/ All from imported clinker.

6/ Production, in thousand carats, includes that of Akwatia Mine [1994--356; 1995--294; 1996--271; 1997--300 (estimated), and 1998--252]. Estimates of unreported artisanal production not included.

7/ Does not include estimate of smuggled production.

TABLE 2
GHANA: STRUCTURE OF THE MINERAL INDUSTRY IN 1998

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Aluminum thousand metric tons	Volta Aluminum Co. Ltd. (VALCO) (Kaiser Aluminum & Chemical Corp., 90%; Reynolds Metals Corp., 10%)	Aluminum smelter at Tema	200.
Bauxite do.	Ghana Bauxite Co. Ltd. (Alcan Aluminum Ltd., 80%, Government, 20%)	Bauxite mine at Awaso	500. 1/
Cement do.	Ghana Cement Works Ltd. (Scancem International ANS, Norway, 59.5%, Government, 40%; other, 0.5%)	Clinker grinding plant at: Takoradi Tema	400. 700.
Diamond thousand carats	Ghana Consolidated Diamonds Ltd. (Government, 100%)	Placer mine at Akwatia	360.
Gold kilograms	Ashanti Goldfields Co. Ltd. [Depository Nominee, Inc. (Ashanti), 36.1%; Lonmin, Plc., United Kingdom, 31.5%; Government, 19%; other private, 13.4%]	Obusai mines; surface operations phasing out in 1999-2000 Iduapriem Mine, (closing in 2000) Bibiani Mine Ayanfuri Mine Prestea Sankofa Tailings Asikam alluvial operation	28,000. 5,000. 5,000. 1,800. 650. 250.
Do.	do. (Ashanti Goldfields, 60% interest in Midras Mining) Ashanti Goldfields total capacity in Ghana	do.	40,700.
Do.	do. Abooso Goldfields Ltd. [Ranger Minerals Ltd. (Australia), 90%; Government, 10%]	Damang Mine near Tarkwa (1998 start-up)	9,000.
Do.	do. Barnex (Prestea) Limited, [Barnto Exploration Ltd., (South Africa), 90%; Government, 10%]	Prestea underground mine	1,100.
Do.	do. Bogosu Gold Ltd. (Gencor Ltd. holdings sold?); IFC, 9%; Government, 10%)	Open pit mine at Bogosu	3,100.
Do.	do. Bonte Gold Mining Ltd. (Akrokeri-Ashanti Gold Mines, Inc., Canada, 85%; Government, 10%; Buosiako Co. Ltd., Ghana, 5%)	Placer mine at Esaase, about 40 kilometers southwest of Kumasi	1,100.
Do.	do. Dunkwa Continental Goldfields Ltd.	Offin River dredging operation, along border of Ashanti & Central Regions.	175.
Do.	do. Gold Fields Ghana Ltd. (Gold Fields of South Africa Ltd., 70%; Golden Knight Resources Inc. of Canada, 17.5%; Government, 10%; Social Security and National Insurance Trust, 2.5%)	Tarkwa underground mine, closing end of 1999. Tarkwa open pit start-up in 1998 (Full capacity at end 1999)	1,500. 3,110, (7,776).
Do.	do. Resolute Amansie Ltd. [Resolute Ltd. (Australia), 90%; Government, 10%]	Obotan Mine 40 km northwest of Obuasi	3,920, to 4,666 in future.
Do.	do. Satellite Goldfields Ltd. [Wassa Holdings Ltd, 90% (of which Glencar Mining plc. of Ireland holds 66%); Government, 10%].	Wassa Mine (Jan. 1999 start-up) 30 km northeast of Tarkwa	3,730.
Do.	do. Teberebie Goldfields Ltd. (Pioneer Group Inc., United States, 90%; Government, 10%)	Teberebie open pit mine near Tarkwa	8,000. e/
Manganese ore thousand metric tons	Ghana Manganese Company Limited (Government, minority interest)	Open pit mine at Nsuta-Wassaw in Western Region	550 (processed ore).
Steel do.	Steelworks Co. subsidiary of Ghana Industrial Holdings Co. (Government, 100%)	Steel mill at Tema	2.5 (rebar)*
Do.	do. Wahome Steel Ltd. (private Taiwanese investors, 95%; Ghanaian investor, 5%)	do.	30 (rod, rebar, and wire).
Petroleum prod thousand barrels	Tema Oil Refinery (Government, 100%)	Refinery at Tema	10,600 (crude input).

e/ Estimated.

1/ To double capacity to 1 million metric tons by 2001.

TABLE 3
GHANA: GOLD PRODUCTION BY COMPANY AND MINE

(Kilograms)

Company	Mine	1994	1995	1996	1997	1998
Abosso Goldfields Ltd. (Ranger Minerals)	Damang, open pit	--	--	--	--	8,421
Ashanti Goldfields Co. Ltd.	Ayanfuri, open pit 1/	139	1,744	1,717	1,807	1,440
Do.	Bibiani	--	--	--	--	4,719
Do.	Iduapriem, open pit 2/	3,689	3,866	3,669	4,560	4,828
Do.	Asikam, alluvial, (Midras Mining)	--	--	--	--	233
Do.	Obuasi, open pit and underground	26,548	29,138	26,761	26,687	27,537
Do.	Pretea Sankofa, tailings 3/	--	184	540	626	467
Total		30,376	34,748	32,147	33,054	39,224
Barnex (Pretea) Ltd.	Pretea, underground 4/	612	840	1,062	1,011	600
Bogoso Gold Ltd. (Billiton)	Bogoso, open pit	3,402	3,349	3,327	3,464	3,813
Bonte Gold Mines Ltd.	Esaase, placer	508	567	668	879	1,093
Dunkwa Continental Goldfields Ltd.	Dunkwa, placer 5/	97	104	173	118	37
Gold Fields (Ghana) Ltd.	Tarkwa, underground 6/	1,224	1,382	1,476	1,672	1,670
Do.	Tarkwa, open pit, 1998 startup	--	--	--	--	2,522
Obenemasi Gold Mines Ltd.	Konongo/Obenemasi, open pit	--	690	588	176	--
Precious Minerals Marketing Corp.	Artisanal workings 7/	1,772	3,898	2,913	3,331	1,873
Resolute Amansie Ltd.	Obotan, open pit	--	--	--	2151	5,411
Teberebie Goldfields Ltd.	Teberebie, open pit	5,487	7,325	6,317	8,180	7,877
Total		43,478	53,087	49,211	54,662	72,541

1/ Acquired in purchase of Cluff Resources in 1996; 1659 kilograms attributed to Ashanti in 1996.

2/ Acquired in merger with Golden Shamrock in 1996; 590 kilograms attributed to Ashanti in 1996.

3/ Acquired in purchase of SAMAX Gold Inc. in 1998

4/ Acquired from State Gold Mining Corp. (SGMC) in 1996.

5/ Acquired from SGMC in 1995.

6/ Acquired from SGMC in 1993.

7/ Includes 8 to 110 kilograms per year byproduct gold from Ghana Consolidated Diamonds Ltd.'s Akwatia Mine.

Sources: Ghana Minerals Commission and Ghana Chamber of Mines.

THE MINERAL INDUSTRY OF GUINEA

By Philip M. Mobbs

Guinea was the world's second largest bauxite producer and had the world's largest bauxite resources (Plunkert, 1999). Mining accounted for about 16% of the nation's estimated \$3.6 billion gross domestic product and about 80% of the value of Guinea's exports (U.S. Department of State, September 1998, Background notes, accessed November 13, 1999, at URL <http://www.eti-bull.net/USEMBASSY/notes.html>; World Bank, September 22, 1999, Guinea at a glance, accessed November 10, 1999, at URL <http://www.worldbank.org/data/countrydata/countrydata.html>).¹ The limited domestic demand for crude minerals resulted in the mineral sector effectively dominating the nation's exports. Less than 10% of mined bauxite was used to produce alumina in Guinea. In 1998, the country's total exports were valued at \$843 million compared with \$797 million in 1997 (World Bank, September 22, 1999, Guinea at a glance, accessed November 10, 1999, at URL <http://www.worldbank.org/data/countrydata/countrydata.html>). Guinea supplied about 35% of the U.S. metallurgical-grade bauxite imports in 1998 (P. Plunkert, U.S. Geological Survey, Mineral Industry Surveys—U.S. trade in bauxite and alumina in the first quarter 1999, accessed November 13, 1999, at URL <http://minerals.usgs.gov/minerals/pubs/commodity/bauxite/09004199.pdf>).

The Mining Code of 1995, as amended by Arrêté No. A98/5874/MRNE/SGG of August 10, 1998, defines incentives, mineral ownership, mining fees, mining titles, royalties, and other taxes. The Government reserves 15% free equity for itself in all gold and gem operations. State participation in bauxite- and iron-ore-mining ventures is subject to negotiation. Mineral beneficiation in Guinea is encouraged. Royalties are 5% on alumina and 3.5% on concentrates of other minerals compared with 10% on bauxite and 7% on other ores. The corporate income tax rate is 35%.

In addition to possessing significant bauxite reserves, Guinea has diamond, gold, granite, and iron deposits. The Government encouraged the foreign participation in the bauxite sector and promoted the diversification of the mineral industry. The investment bank UBS Warburg Dillon Read was advising the Government on the restructuring of the bauxite industry, but the mineral industry privatization program was proceeding slower than expected.

The 14-million-metric-ton-per-year (Mt/yr)-capacity Compagnie des Bauxites de Guinée (CBG) operated a number of open pit bauxite mines in the Boké District, including the Sangarédi Mine. CBG was controlled by the Government (49%) and Halco Mining Inc. (51%), a consortium comprising Alcan Aluminium Ltd. of Canada, Aluminium Pechiney of France, and Alcoa Inc. of the United States. In 1998, to

debottleneck production, CBG began rehabilitation and upgrade of the bauxite conveyor system in Kamsar from the rail terminal to the processing plant.

The state-owned Société des Bauxites de Kindia (SBK) proposed to restore its production to the operation's original 3-Mt/yr capacity. SBK's production, about one-half of capacity, was exported to Ukraine.

The dispute between the owners of the Société d'Economie Mixte Friguia continued into 1998. Friguia, owned by the Frialco Holding Co. (51%) and the Government (49%), operated the Fria bauxite mine and the Kimbo alumina refinery. The year began with the Frialco partners (Alcan, 20%; Aluminium Pechiney, 30%; Hydro Aluminium a.s. of Norway, 20%; and Noranda Inc. of Canada, 30%) actively looking to divest their interest in the consortium. The Government was attempting to privatize 34% of its interest in Friguia, but the October 1998 privatization was postponed until 1999. In October, the Government took control of the Frialco consortium's interest in Friguia and subsequently offered to privatize 100% of the equity interest in the company (African Energy & Mining, 1998; Metal Bulletin, 1998).

During 1998, Union Mining NL of Australia awaited Government approval of its reconnaissance permits for the Gaoual bauxite deposits in northwestern Guinea.

Artisanal operators were significant gold producers, accounting for about 80% of the national gold output at the beginning of the year, but by yearend, commercial operations were mining more than 50% of the gold produced in Guinea (European Union, 1998, Mines '98—Guinea, accessed August 25, 1998, at URL <http://www.landscape.de/mines98/country/gn/index.htm>). Delta Gold Mining (85%), a corporation of the United Kingdom, and Société Minière de Dinguiraye (SMD), owned by the Government (15%), operated the open pit Léro gold mine. Delta's ownership was consolidated in 1998, when Kenor ASA of Norway bought out joint-venture partner Mine Or S.A., the gold operations subsidiary of La Source Group of France. The Léro operation produced 1,717 kilograms (kg) of gold in 1998 compared with 1,504 kg in 1997 (Kenor ASA, 1999). Also on the Dinguiraye concession, SMD started producing ore from the Karta 2 Mine, across the Karta River from the Léro Mine, and began leaching tests on ore from the Fayalala deposit's Faycap 1 Mine, about 8 kilometers (km) east of Léro's facilities. SMD continued exploration on the Tambico prospect, 2 km northwest of Fayalala.

The \$55.7 million Siguiri Mine began operating in 1998 and soon became the largest gold mine in Guinea, as production reached 6,030 kg for the year (Ashanti Goldfields Co. Ltd., January 27, 1999, Ashanti announces strong production and cost reductions for 1998, press release, accessed May 19, 1999, at URL <http://www.ashanti.com.gh/pressreleases/current/seann170.htm>). Run by Société Ashanti Goldfields de Guinée,

¹Where necessary, values have been converted from Guinean francs (GnF) to U.S. dollars at the average exchange rate of GnF1,225=US\$1.00.

the 4-Mt/yr-capacity heap-leach operation at Siguiri was owned by Ashanti Goldfields Co. Ltd. of Ghana (85%) and the Government (15%). At yearend, Société Ashanti Goldfields de Guinée began a \$27 million expansion to double ore-processing capacity to 8 Mt/yr (Australia's Paydirt, 1998). Near Siguiri, Société Ashanti Goldfields de Guinée continued its evaluation of the Kosise deposit and the Sanu Tinti pit and was drilling on the Foulata prospect 35 km west of Siguiri. The alliance of Ashanti and IAMGold Corp. of Canada continued evaluation of the Mandiana gold concession and was seeking additional partners for the project.

Les Minéraux SGV S.A., a subsidiary of Semafo (Barbados) Ltd., reevaluated the Gobeles and the Jean gold deposits by means of additional drilling in 1998. At yearend, Semafo was negotiating a development agreement. Les Minéraux SGV also was exploring a Simandou area gold prospect.

For many junior mining companies, 1998 was a difficult year to raise funds for exploration and development projects. The decreased availability of financing resulted in several companies pulling out of Guinea or significantly reducing their exploration activity. African Selection Mining Corp. of Canada maintained the EcoGuinée and Bassorides gold exploration permits. International Chalice Resources Inc. of Canada (formerly Chalice Mining Inc.) relinquished the Heremankono property. Goldex AS, a wholly owned subsidiary of Kenor, carried out exploration on the Farabana exploration permit. Leo Shield Exploration NL of Australia was looking for partners for its interest in gold exploration concessions in Guinea. Golden Limbo Rock Ressources S.A., a subsidiary of Mano River Resources Inc. of Switzerland, continued its evaluation of the Gueliban and the Missimana gold properties. Moydow Mines International Inc. of Ireland retained the Kissi Kissi property in Guinea. Prospector International Resources Inc. of Canada (formerly Pacific Galleon Mining Corp.) held the Bananfara concession. Prospec Mining Inc. of Canada was evaluating the Beyla and the Kindia gold concessions and submitted applications for gold exploration permits near Gaoual, Kifaya, and Siguiri. Reunion Mining plc of the United Kingdom and First Quantum Minerals Ltd. of Canada wrote off their interest in the Nyantanina gold permit. SAGEM S.A. of Guinea and New Sage Resources Ltd., the Canadian subsidiary of Striker Resources NL of Australia, wound down exploration of the Sankarani gold deposit. Société Minière de Kérouané, a venture of Lithos Corp. of Canada and local partners, was exploring for gold on the Apredor concession. Voyager Gold NL of Australia acquired several gold permits from West African Gold Mines of Australia, including the Bankole prospect.

Rio Tinto plc of the United Kingdom was exploring the iron deposits in the Simandou Range. Semafo Guinée S.A. was exploring the Kaloum/Mount Kakoulima nickel prospect in a joint venture with AFCAN Mining Corp. of Canada. A geophysical survey was run on the prospect, about 50 km from Conakry.

Nationwide, 70% to 80% of diamond production was of gem quality. More than 80% of production was from indigenous artisanal operations. In February, as part of a legal settlement, Trivalence Mining Corp. of Canada bought out the 25.5% equity interest that Consolidated African Mining Ltd. of South Africa had held in Aredor FCMC S.A. Aredor FCMC's ownership at yearend was First City Mining Co. Ltd., a

subsidiary of Trivalence (85%) and the Government (15%). In March, Aredor FCMC commissioned a mobile 4.3-meter (m) pan plant. The plant had a capacity of 720,000-metric-ton-per-year (t/yr) of gravel. The company began upgrading the existing 240,000-t/yr-capacity twin 2.4-m pan plant on the concession. Aredor FCMC also was processing samples from the concession's kimberlite deposits and had a second 4.3-m pan plant that was processing tailings left by the concession's previous operator. Aredor FCMC diamond production in 1998 was about 19,000 carats (Trivalence Mining Corp., 1999).

Through its subsidiaries, Hymex Guinée S.A. and Hymex Milo S.A., Hymex Diamond Corp. of Canada recovered 15,162 stones weighing 9,753 carats from alluvial diamond operations on its Kérouané region concession. Production was significantly lower than that of 1997 as Hymex tested the new 150-cubic-meter-per-hour-capacity wash plant on the Diani permit until company financial difficulties resulted in the operation shutting down in August (Hymex Diamond Corp., October 11, 1999, Form 61—Quarterly report for quarter ending December 31, 1998, accessed November 13, 1999, via URL http://www.sedar.com/dynamic_pages/assoc_docs_e/d00002834.htm).

African Resources Inc. of Canada (formerly Alpha Diamond Corp.) and Gold Rivers of Africa Corp. were dredging on a diamond and gold mining concession on the Konkoure River at Téliélé. The joint venture of Arena Gold Resources Inc. (60%), La Société Minière de Kérouané (SMK) S.A. (25%), and the Government (15%) held an exploration permit for diamond in the Apredor area, north of the permit held by Trivalence. De Beers Consolidated Mines Ltd. of South Africa was evaluating its 13 kimberlite exploration concessions and had applied for an additional 5 diamond concessions.

Total bauxite reserves were estimated to be about 20 billion metric tons grading more than 40% aluminum oxide, according to the Ministry of Natural Resources and Energy. Iron resources were estimated to be about 6 billion tons grading 64% to 68% iron, and gold reserves were estimated to be between 200 and 1,000 metric tons of contained gold. The Government also estimated that reserves of diamond in Guinea were 20 million carats (Ministère des Ressources Naturelles et de l'Énergie, 1997).

Major highways have been paved, but the rural transportation infrastructure was inadequate to meet demand. Guinea had two main ports—Conakry and Kamsar. Conakry, the country's main general cargo port, was linked to the Kinda Mine by a 104-km 1.435-m standard-gauge railroad line and to the Fria Mine by a 145-km 1-m narrow-gauge railway. Kamsar, which handled only bauxite shipments, was linked to the Sangarédi Mine by a 135-km standard-gauge railroad line. In addition to the mine railroads, a 661-km 1-m gauge line connected Conakry with Kankan.

Guinea had a nominal installed electricity generating capacity of about 197 megawatts (MW), of which thermal plants accounted for 145 MW and hydroelectric powerplants accounted for 52 MW; however, many thermal plants and the generators at the Kinkon and the Tinkisso dams operated intermittently, resulting in a tangible generating capacity of about 100 MW (GuinéeNews, June 1998, *Espoirs énergétiques en Guinée*, accessed November 9, 1998, at URL <http://www.myna.com/~boubah/GUINEE/ARCHIVES/9806.htm>). Mining

companies accounted for about 50% of the thermal power production. At yearend, the Government proposed to privatize the national electric power generating, transmission, and distribution network.

Although the 1995 mining code significantly improved the business climate for the mineral industry, mining operations remained hampered by infrastructural constraints. International funding of mineral deposit development was proceeding more slowly than anticipated. The less-than-expected foreign investment was attributed to the country's perceived political and economic risks and decreased availability of financing for junior mining companies, as well as civil disturbances in the adjacent countries of Guinea-Bissau, Senegal, and Sierra Leone.

Alumina, bauxite, and gold production are expected to continue dominating Guinea's economic activity. Ventures requiring significant electric power availability, such as an aluminum smelter, could become feasible as the nation's power-generation capacity is increased.

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TABLE 1
GUINEA: PRODUCTION OF MINERAL COMMODITIES 1/

(Thousand metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997 e/	1998 e/
Alumina:					
Production:					
Hydrate	648	630	650	527	490
Calcined	640	616	640	520	480
Shipments, calcined	545	616	619	500	511
Bauxite:					
Mine production:					
Wet basis 2/	14,900	18,000	18,700	19,250	17,000
Dry basis 3/	13,300	15,800	16,500	17,100	15,000
Calcined	89	244	95	100	100
Shipments (dry basis):					
Metallurgical	11,033	12,304	13,000 e/	14,500	14,000
Calcined	91	89	95	95	100
Diamond 4/ 5/	381	365	205	205	400
Gold 5/	5,617	7,863	6,838	7,000	14,000

e/ Estimated.

1/ In addition to the commodities listed, modest quantities of crude construction materials (clays, sand and gravel, and stone) presumably are produced, but output is not reported. Table includes data available through November 15, 1999.

2/ Metallurgical plus calcinable ore estimated to be 13% water.

3/ Data are for wet-basis ore estimated to be 13% water, reduced to dry basis estimated to be 3% water.

4/ Production is approximately 70% to 80% gem quality.

5/ Figures include artisanal production.

THE MINERAL INDUSTRY OF GUINEA-BISSAU

By Philip M. Mobbs

Agriculture dominated the economy of Guinea-Bissau, with construction accounting for about 10% of the gross domestic product. The intermittent domestic demand for construction materials, such as clay, gravel, and sand has sustained small-scale mining activity. The development of the mineral resources of Guinea-Bissau was attracting international interest; however, a military coup enveloped the country in civil war in June 1998, severely disrupting ongoing and proposed mineral operations. The November 1998 peace accord dissolved during renewed fighting in January 1999.

Guinea-Bissau joined the Western African Monetary Union in 1997, subsequently converting the national currency from the Guinea-Bissauan peso to the Communauté Financière Africaine (CFA) franc. The Government also revised the national tax system, including customs tariffs and excise taxes. Guinea-Bissau was a member of the African legal accord—Organization pour l'Harmonization du Droit des Affaires en Afrique. Applications for export and investment incentives passed through the Government's Private Investment Promotion Office. The Ministry of Energy, Industry, and Natural Resources was responsible for the mineral industry and the 1990 mining code was under review.

Bauxite had been discovered in the Boé region, about 150 kilometers (km) east of Bissau, by N.V. Billiton Maatschappij of the Netherlands during the late 1950's. The Soviets drilled the Boé deposits in the early 1970's, and Tsvetmet Promexport of the U.S.S.R. prepared a feasibility study on the deposits in the 1983. Reserves estimates of 110 million metric tons (Mt) of bauxite with an average grade of 44% Al_2O_3 and 4% SiO_2 have been published (U.S. Agency for International Development, 1998, Guinea-Bissau investing—Location specific mining and offshore drilling, accessed November 3, 1998, at URL <http://www.investgb.com/engv/emine.html>).

The United Nations Development Programme began investigations of the Farim phosphate deposit, approximately 75 km northeast of Bissau, in 1978. The Bureau de Recherches Géologiques et Minières of France studied the deposit from 1981 to 1985 and Sofremines prepared a positive prefeasibility study in 1986; however, market conditions impeded development. In 1997, Champion Resources Inc. of Canada acquired a 2-year, countrywide exploration permit and the exploration concession on the Farim deposit. Champion

estimated an initial capital cost of \$101 million to develop the 115-Mt phosphate deposit (Champion Resources Inc., December 4, 1997, [untitled], press release, accessed February 20, 1998, at URL http://www.championresources.com/news/chl_120497.html). Analysis of core recovered during a 1998 drilling program reported an average 30.6% P_2O_5 content and cadmium values ranging from 6 to 12 parts per million (Champion Resources Inc., August 17, 1998, [untitled], press release, accessed May 7, 1999, at URL http://www.championresources.com/news/chl_081798.html). The Farim concession subsequently was transferred to a Champion subsidiary, Champion Industrial Minerals Inc.

In the mineral fuels sector, Petrobank Energy and Resources Ltd. of Canada (70%) and the state company Empresa Nacional de Pesquisa e Exploração de Guiné-Bissau (Petroguin) (30%) had a seismic survey on offshore block 2 shot and processed. During 1998, interpretation of the seismic data confirmed the potential for salt dome-related traps on the block; however, the civil unrest impeded initiation of drilling operations. In 1997, the joint venture of West Oil NL and Fusion Investments Ltd. of Australia agreed to survey the formerly disputed offshore border region between Guinea-Bissau and Senegal for the Agence de Gestion et de Coopération entre la Guinée-Bissau et le Sénégal. In 1998, West reinterpreted existing seismic data coverage. IKODA Ltd. of the United Kingdom was preparing a promotional report for the prospect. Monument Oil and Gas Plc of the United Kingdom, Sociedad Internacional Petrolera S.A. of Chile, and Petroguin relinquished the offshore Becuda license in 1998 after evaluation of geochemical and geophysical surveys of the prospect.

Development of the bauxite and phosphate deposits had been hampered in the past by the lack of suitable transportation infrastructure. The Government was interested in constructing a deepwater terminal at Buba.

Major Source of Information

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THE MINERAL INDUSTRY OF

KENYA

By Philip M. Mobbs

Kenya, with its cement plants, petroleum refinery, and steel mills, was the most industrialized country in eastern Africa. Mineral and mineral-based commodities produced in Kenya included cement, fluorspar, gemstones, gold, gypsum, lime, petroleum products, salt, soda ash and steel products. Mining and quarrying in this East African nation of 29.6 million people accounted for less than 1% of the country's gross domestic product (GDP), which was \$9.96 billion in 1998 (Central Bank of Kenya, September 1999, Monthly economic reviews, accessed September 21, 1999, at URL <http://home.centralbank.go.ke/Tables/review/133-6943323.html>). The country's economic performance continued to slow in 1998. Real GDP growth was 1.8% in 1998 compared with 2.3% in 1997 and 4.6% in 1996 (Central Bank of Kenya, September 1999, Monthly economic reviews, accessed September 21, 1999, at URL <http://home.centralbank.go.ke/Tables/review/133-6943323.html>). Reasons cited by the Central Bank for the downturn included the poor condition of Kenya's infrastructure and eroded investor confidence (Central Bank of Kenya, March 1999, Monthly economic reviews—Economic growth update, accessed September 21, 1999, at URL <http://home.centralbank.go.ke/MonthlyReviews/ShowReview.asp?DocumentID=723>). The cement, steel, and construction material sectors suffered from lack of demand as activity in the building and construction industry contracted. Inexpensive cement and steel imports also adversely affected demand for local production (Metal Bulletin, 1998).

Kenya's major trading partners in Africa and the European Union received about 80% of the nation's exports. Agricultural products dominated the export market, but fluorspar, gemstones, petroleum products, soda ash, and steel products were notable sources of foreign exchange earnings. Petroleum products, refined primarily from crude oil imported from the United Arab Emirates, were reexported to neighboring African countries, particularly Uganda.

Gold production was mainly artisanal. Depressed gold prices dampened international gold exploration activity in Kenya. Early in the year, Anglo American Prospecting Services Ltd., a subsidiary of Anglo American Corp. of South Africa, relinquished its exploration option on the Lolgorien and the Akala concessions held by International Gold Exploration AB of Sweden (IGE). In 1998, exploratory drilling resulted in the discovery of the Teng-Teng deposit on the Lolgorien concession, and exploration continued on the Sekerr gold concession. Throughput at IGE's gold mine dump tailings retreatment on the Lolgorien property was increased to 12,000 metric tons per year.

Tanganyika Gold NL of Australia acquired Panorama Resources NL of Australia and its subsidiary, Auvista Minerals NL. Exploration activity was cut back on the Migori gold prospect, where the joint venture of Tanganyika (60 %) and Mio

Migori Mining Co. Ltd. of Kenya (40%) held two special prospecting licenses. In October 1997, Panorama had reported estimated resources of 7.4 million metric tons (Mt) grading 2.37 grams per ton of gold (Tanganyika Gold NL, [undated], Migori gold project—Kenya, accessed September 20, 1999, at URL <http://www.tangold.com.au/annual/other.html>).

Pan African Resources Corp., a wholly owned subsidiary of Golden Star Resources Ltd. of Canada, held the option to acquire a 75% interest in the Ndori gold prospect in southwestern Kenya from San Martin Mining Research and Investment Co. Ltd. of Switzerland and San Martin 96 S.A. Exploration activity was significantly reduced on the prospect owing to Golden Star's budget prioritization.

Tiomin Resources Inc. of Canada continued work on its special prospecting licenses covering, from north to south, the Sabaki, the Mambui, the Kilifi (formerly the Sokoke), the Mombasa, and the Kwale titanium-bearing heavy mineral sand concessions. A feasibility study was begun on the Kwale permit. The resource of mineralized sands at Kwale was 200 Mt containing an estimated 3.8 Mt of ilmenite, 1.0 Mt of rutile, and 600,000 metric tons (t) of zircon at a 1% heavy-mineral cutoff grade (Canada NewsWire, November 30, 1998, Tiomin Resources Inc.—Third quarterly report 1998, sent November 30, 1998, from e-mail portfolio@newswire.ca). Resources at Mambui were 700 Mt of sand containing an estimated 14 Mt of ilmenite, 700,000 t of rutile, and 700,000 t of zircon. Resources at Kilifi were estimated to be 1,700 Mt of sand containing an estimated 18.7 Mt of ilmenite, 1.7 Mt of rutile, and 1.7 Mt of zircon. Tiomin continued to lease property for the proposed \$98 million Kwale project; however, the leasing negotiations and Tiomin's proposed port facility at Shimoni, 35 kilometers south of Kwale, were becoming controversial. Local officials were not satisfied with the lease terms offered farmers and squatters (Industrial Minerals, 1997; Mining Journal, 1997; Africa Energy & Mining, 1999; Tiomin Resources Inc., 1999; Daily Nation, May 15, 1998, Feud over titanium project rages in Kwale, accessed May 15, 1998, at URL <http://www.nationaudio.com/News/DailyNation/Today/News/News21.html>; Daily Nation, July 4, 1998, Titanium mining firm given conditions, accessed July 6, 1998, at URL <http://www.nationaudio.com/News/DailyNation/Today/040798/News/News12.html>). Pangea Goldfields Inc. of Canada held a 20% interest in the mineral sand concessions.

In 1998, Athi River Mining Ltd. started up its third cement kiln and opened a second lime kiln in Mombasa. Bamburi Cement Ltd. of Mombasa built a \$40 million cement clinker grinding mill at Athi River, near Nairobi, and began operations in August. The mining of limestone from the Ortum area in the West Pokot District and the export of the rock to Tororo, Uganda, continued to be disputed. Local leaders wanted a cement factory to be built in the West Pokot area instead of just

a quarrying operation (Daily Nation, July 20, 1998, Government stops limestone shipments, accessed July 20, 1998, at URL <http://www.nationaudio.com/News/DailyNation/Today/News/Business2.html>).

Salt production in eastern Kenya had been adversely affected by the late 1997 rains that flooded the salt ponds. Local production was supplemented by imports; however, salt imports from Eritrea dried up when Ethiopia and Eritrea went to war in May 1998, forcing salt companies to seek yet another source of imports.

In September 1998, Soda Ash Investments Plc of the United Kingdom acquired Brunner Mond Plc of the United Kingdom, and its Kenyan subsidiary, Magadi Soda Co. Ltd. Magadi Soda, Africa's largest soda ash producer, exported most of its production to India, South Africa, Southeastern Asia and Tanzania.

Petroleum exploration faltered in 1998 when Tornado Resources Ltd. of Canada, holding production-sharing agreements on blocks L-1 and L-10, ran into financial difficulty (Tornado Resources Ltd., 1998).

Refined petroleum products were moved from the Mombasa refinery and through the Mombasa petroleum import terminal to the interior by the pipeline of the Government-owned Kenya Pipelines Co. Ltd. and by trucks. In 1998, the Government banned oil transport by truck to Ethiopia, Somalia, and Sudan. Some petroleum cargo bound for Burundi, Rwanda, and Uganda continued to be moved across Kenya by truck despite the road conditions (J. A. Emojong, September 30, 1998, Kenya impounds heavy trucks to save the roads, Monitor, accessed March 4, 1999, at URL <http://www.africanews.com/monitor/freeissues/30Sep98/business.html>).

The Kenya Railways Corp. single-track line runs from the west near Tororo, Uganda, passes through Nairobi, and terminates at the Indian Ocean port of Mombasa, connecting key mining districts along the route. In February, the World Food Programme agreed to fund a \$1.3 million program to rehabilitate 10 locomotives for the Kenya Railways (World Food Programme, 1998). In May, Brunner Mond commissioned three locomotives for the Magadi Railway Co., Kenya's first private railroad company. Magadi Railway completed an \$8.9 million reconstruction of the track from Magadi to Konza, formerly maintained by Kenya Railways (Barrack Otieno, May 1998, Kenya's first private railway, African Business, accessed November 21, 1998, at URL <http://dialspace.dial.pipex.com/icpubs/ab/may98/abts0501.htm>). CPCS Transcom Ltd. of Canada continued a study of the Kenya Railways privatization options for the Government.

Kenya's 68,000-kilometer road system was in poor condition. Maintenance problems were exacerbated by overloaded trucks

and the heavy rains of late 1997 that washed away bridges and roadbeds.

The state-owned Kenya Electricity Generating Co. produced electricity, and the state-owned Kenya Power and Light Co. distributed the power; however, electricity demand continued to outpace supply (Indian Ocean Newsletter, 1997). Primarily derived from hydroelectric sources, Kenya had an electric generating capacity of about 806 megawatts (MW) (Indian Ocean Newsletter, 1998). An additional 30 MW was imported from Uganda. Construction of a 75-MW powerplant at Kipevu in Mombasa continued. Ormat International Ltd. of the United States contracted to build the Olkaria III powerplant, a 64-MW geothermal facility. Negotiations for the construction of a 60-MW hydroelectric powerplant at Sondu Miriu, near Kisumu, and 55-MW thermal plants at Eldoret and at Nakuru, were underway.

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Major Sources of Information

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TABLE 1
KENYA: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity 2/	1994	1995	1996	1997	1998
Aluminum, secondary e/	2,400	2,400	2,400	2,400	2,000
Barite e/	20 3/	20	20	20	10
Carbon dioxide gas, natural	5,605	7,982	9,119	9,214 r/	8,498
Cement, hydraulic thousand tons	1,182	1,566 r/	1,816 r/	1,506 r/	1,200 e/
Clays, kaolin	69	300	595	500 e/	500 e/
Diatomite	592	457	415	297 r/	468
Feldspar e/	1,200	500	100	100	100
Fluorspar (acid grade)	53,400	80,230	83,000	68,700 r/	60,854
Gemstones, precious and semiprecious:					
Amethyst e/ kilograms	303	310	300	104 r/ 4/	166 4/
Aquamarine do.	14	50 e/	50 e/	12 r/ 4/	15 4/
Cordierite (Iolite) e/ do.	15	15	15	19 r/ 4/	34 4/
Garnet do.	42	119	120 e/	18,181 r/ 4/	5,186 4/
Ruby do.	200	1,200	1,200 e/	5,175 r/	4,001
Sapphire e/ do.	2,310	2,300	2,300	615 r/ 4/	3,313 4/
Tourmaline do.	43	224	250 e/	6,969 r/	3,790
Gold, mine output, Au content e/ do.	155	170	300	440 r/ 4/	388 4/
Gypsum and anhydrite e/	500 r/	500 r/	1,000 r/	1,000 r/	1,000
Lead, mine output, Pb content	350	4	5 e/	-- r/	--
Lime e/	12,000	12,000	15,000	15,000	16,000
Petroleum refinery products e/ thousand 42-gallon barrels	16,200	14,600 r/	13,000 r/	13,000 r/	12,000
Salt, crude	70,500	71,400	41,000	6,280 r/	21,742
Soda ash	226,150	218,450	223,000	257,640 r/	242,910
Steel, crude e/ thousand tons	20	20	30 r/	33 r/	25
Stone, sand and gravel:					
Coral e/ do.	1,600	1,600	1,000	500 r/	500
Granite for dimension stone	50	50	100	500 4/	1,619 4/
Limestone for cement thousand tons	300	300	600	700	700
Limestone for dimension stone do.	30	31	32	32	32
Marble for dimension stone	100	100	100	966 4/	84 4/
Sand, industrial (glass) e/	12,300	12,300	13,000	13,000	12,000
Shale e/	150,000 r/	120,000 r/	120,000 r/	200,000 r/	180,000
Vermiculite	1,113 e/	457	734	1,418 r/	353

e/ Estimated. r/ Revised.

1/ Includes data available through September 19, 1999.

2/ In addition to the commodities listed, a variety of minerals and construction materials [brick clays, coal, gravel, iron ore, kyanite, meerschaum, mica, murrum (laterite), crushed rock, and construction sand] may be produced, but quantities are not reported, and information is inadequate to make reliable estimates of output.

3/ Reported figure.

4/ Reported export figure.

THE MINERAL INDUSTRY OF

LESOTHO

By George J. Coakley

The landlocked, 30,350-square-kilometer nation of Lesotho is an independent constitutional monarchy surrounded by the Republic of South Africa. In 1998, the population of this landlocked country was 2.1 million people, and the gross domestic product was estimated to be \$870 million (World Bank, September 3, 1999, Lesotho at a glance, accessed November 26, 1999, via URL <http://www.worldbank.org/data/country/countrydata.html>). A political crisis erupted in 1998. Alleged voting fraud during the May 23 national elections resulted in civil riots and, in September, a military mutiny. The Government invited the insertion of a regional military task force from the Southern African Development Community that subsequently restored civil order (Sechaba Ka'Nkosi, January 22, 1999, Lesotho simmers once again, Daily Mail & Guardian, accessed November 28, 1999, at URL <http://www.mg.co.za/mg/news/99jan2/22jan-lesotho.html>).

Lesotho has long been known as a source of diamonds, mostly from alluvial deposits, but mineral production in Lesotho was not a significant part of the economy. Artisanal miners also produced a small amount of clay, crushed stone, and sand and gravel for domestic consumption. Government revenue was generated from the sale of water to South Africa through the Lesotho Highlands Water Project in the Maluti Mountains. Additionally, repatriated wages from Basotho miners working in the South African gold mines traditionally have contributed significantly to national income. However, the

collapse of international gold prices and resultant downsizing of the South African gold industry labor force lead to layoffs of substantial numbers of Basotho miners (MISAnet/Africa Information Afrique, October 20, 1998, Retrenchment of miners adds to reconstruction woes of Lesotho, accessed October 20, 1998, at URL <http://www.woza.co.za/forum/lesothowoes.htm>).

International commercial interest in the mineral resources of Lesotho was limited to diamonds. During 1998, the lack of funding resulted in the temporary suspension of activity on Messina Diamond Corp. of Canada's Likhobong kimberlite project (Messina Diamond Corp., 1999). DiamondWorks Ltd. of Canada evaluated its portion of the Kao kimberlite pipe and was negotiating to acquire additional interest in the pipe from a local company.

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Major Source of Information

Departments of Mines and Geology
Ministry of Water, Energy and Mining
Maseru, Lesotho

THE MINERAL INDUSTRY OF

LIBERIA

By Philip M. Mobbs

Liberia was attempting to recover from the devastating civil war that ended in 1997. Prior to the war, production of iron ore had accounted for about 20% of Liberia's gross domestic product. Cement production from imported clinker and artisanal production of diamond and gold constituted the postwar mineral industry of Liberia. In 1997, the newly elected Government created Liberian Resources Co. to manage the rehabilitation of the nation's mineral industry. Holistic Resources (West Africa), a subsidiary of Commonwealth Gold of the United Kingdom, which, in turn, was a subsidiary of Amalia Gold Mining & Exploration Co. of South Africa, acquired 40% interest in Liberian Resources for promised exploration activity. Amalia's subsequent financial difficulties resulted in the Government cancelling the venture in June 1998 for contract noncompliance. The Government was revising the mining code and attempting to control the myriad illicit diamond and gold mining operations and illegal diamond traders.

Mining of the remaining Liberian portion of the high-grade Nimba iron ore deposit at Yekepa was discontinued in 1992 because of the war. The facilities at Yekepa of the Iron Mining Co. of Liberia had been thoroughly scavenged [Fondation Hirondelle, March 1, 1999, radio broadcast (Star Radio—Liberian Daily News Bulletin) transcription, accessed March 2, 1999 at URL http://www.africanews.org/west/liberia/stories/19990301_feat1.html]. Amalia promoted the use of the railroad from Yekepa to Buchanan to transport iron ore from the Nimba deposit in Guinea (formerly known as the Mifergui project). Rehabilitation of the railroad through Liberia was estimated by the Government to cost less than \$100 million (Metal Bulletin, 1997). Amalia unsuccessfully negotiated funding plans with the Trinity Alliance and Ivanhoe Capital Corp. of Canada (Africa Energy & Mining, 1998). The Bong iron ore mine, closed in 1990, had been overrun several times during the war. Recovery of the mine's remaining 150 million metric tons of low-grade reserves was considered uneconomic (Metal Bulletin, 1997).

There was limited formal diamond and gold exploration activity—only a few junior mining companies retained

exploration concessions, including Consolidated Venturix Holdings Ltd. of Canada; Freegold of Australia; Mano River Resources Inc. of Canada, formed in 1998 when Zicor Mining Inc. acquired Mano River Resources Ltd.; and Rex Diamond Mining Corp. of Canada. Exploration concessions were also claimed by various subsidiaries of the Greater Ministries International Church of the United States, including Greater Diamond Co. (Liberia) Ltd., Greater Gold Mining Co. Ltd., Greater Aggregates Ltd., and Greater Goldfields Liberia Ltd.

Poor to nonexistent bridge and road conditions impeded access to much of the country, and the nation's electrical power grid had been largely destroyed during the civil war. About 8 megawatts (MW) of generating capacity had been restarted by the state-owned Liberia Electricity Corp. Rehabilitation of the 64-MW Mt. Coffee hydroelectric power plant was estimated by the company to cost \$100 million (Liberia Electricity Corp., 1998, LEC—Master energy recovery and development plan, accessed March 2, 1999, at URL <http://www.integrityonline7.com/yhaplec/lecpres16.htm>).

Rebuilding the transportation infrastructure will create a strong demand for cement and locally produced construction materials. Diamond and gold production should continue unabated; however, additional expansion of Liberia's mineral economy will hinge on improvements in international investor confidence. That will require significant improvements in the level of security; reconstruction of communications, power, and transportation infrastructure; reduction in the level of corruption; reintegration of former combatants; resettlement of displaced population and refugees; and resumption of normal economic activity (Daily Times, 1999).

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- Metal Bulletin, 1997, Liberia welcomes back iron ore investors: Metal Bulletin, no. 8213, September 22, p. 19.

TABLE 1
LIBERIA: ESTIMATED PRODUCTION OF MINERAL COMMODITIES 1/ 2/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997	1998
Cement, hydraulic 3/	3,000 r/	5,000 r/	15,000 r/	7,000 r/	10,000
Diamond carats	100,000	150,000	150,000	200,000 r/	300,000
Gold kilograms	700	800	700	500	800

r/ Revised.

1/ Includes data available through May 21, 1999.

2/ In addition to the commodities listed, a variety of industrial minerals and construction materials (clays, gypsum, sand and gravel, and stone) are produced, but information is inadequate to make reliable estimates of output.

3/ Cement production from the Liberian Cement Corporation had been reported as zero between 1994 and 1997 because of the civil war. The Scancem AB annual report indicates that the cement plant was open during most of the civil war.

LIBYA

By Bernadette Michalski

Because Libya lacked substantial industrial diversification, nearly 95% of its revenues were attributed to the hydrocarbon sector. The country's financial position worsened considerably in 1998 owing to falling oil prices. Es Sider (36.5 °API gravity) crude oil averaged \$12.52 per barrel in 1998, down from \$18.99 per barrel in 1997. Oil revenues were just \$5,520 million in 1998. Despite U.S. sanctions, foreign investment in the oil sector continued, particularly from European companies. Libya's petroleum reserves were the largest on the African Continent but remained underexploited. Libya was, however, the second largest crude oil producer in Africa, following Nigeria. With the exception of the heavily subsidized Libyan Iron and Steel Co. (LISCO), which was supplied by imported raw materials, the nation's nonfuel mineral industry sector offered little contribution to the economy. Nonfuel mineral output was confined to the extraction of salt from the coastal plains near Benghazi and Tripoli and the quarrying of clay, gypsum, and limestone near Al Khums. LISCO's iron and steel complex was operating at about three-fourths of its design capacity of 1.2 million metric tons per year (Mt/yr). (See table 1.)

In 1998, Libya exported about 110,000 barrels per day (bbl/d) of crude oil and products to Morocco and Tunisia under barter deals. Total crude oil exports have averaged from 1.0 to 1.2 million barrels per day for the past 6 years. Italy remained Libya's largest single market, absorbing more than 40% of Libyan crude exports. A new export grade at 43° API gravity and 0.07% sulfur was introduced in September 1998. The crude was derived from Es Shahara Field in Block NC-115 in the Murzuk Basin, operated by the Repsol Group of Spain.

The major undeveloped mineral resource in the country was the Wadi Shatti iron ore deposit. The deposit consists of three horizons, the upper and lower comprising 375 million metric tons (Mt) of nonmagnetic iron ore at 48% Fe and the middle horizon comprising 420 Mt of magnetic iron ore at 55% Fe. The deposit is shallow dipping and amenable to open pit mining (Mining Journal, 1999).

The LISCO iron and steel plant at Misurata included two 550,000-metric-ton-per-year (t/yr) Midrex direct reduction (DR) modules, six electric furnaces with a combined capacity of 1.25 Mt/yr, and a 140,000-t/yr cold-rolling mill. Although the plant had been operating at below capacity, construction of a third DR module with a 650,000-t/yr capacity was completed in 1998.

Cement manufacture was the sole domain of two

parastatals—the Arabian Cement Co. and the Libyan Cement Co. Arabian Cement operated four plants—El Mergeb with a 330,000-t/yr capacity, and Souk, El Khamis, and Lebda each with a 1-M/yr capacity. Libyan Cement operated the El Hawari cement plant at Benghazi and the El Fatayeh Cement Factory at Derna, each with a 1-M/yr capacity. Production satisfied most domestic requirements, and very little surplus was available for export; on average, capacity utilization was 50%.

Repsol began to export from its Murzuk acreage in mid-1998. Initial production from the field was 75,000 bbl/d, rising to 125,000 bbl/d by yearend and 200,000 bbl/d by the first quarter of 1999. The field was owned by Repsol, Austria's OMV Aktiengesellschaft, France's Total S.A., and Libya's National Oil Co. (Middle East Economic Digest, 1998). Lasmo plc of the United Kingdom reported that its Elephant Field discovery, which is also in the Murzuk Basin, could have oil reserves of more than 500 million barrels. On the basis of drilling of its first and second appraisal wells, the company hoped to be in production by 1999.

Red Sea Oil Corp. discovered the En Naga North and the En Naga West Fields in 1998. Initial production was expected in 2000 when En Naga North will come on-stream. Peak output will be about 30,000 bbl/d and can be sustained for 3 to 4 years (Arab Petroleum Research Center, 1999, p. 258).

The five domestic refineries had a nominal capacity of 342,000 bbl/d. In addition, Libya's European refineries in Germany, Italy, and Switzerland had a combined refining capacity of 300,000 bbl/d (Arab Petroleum Research Center, 1999, p. 259). Libya ran distribution networks in these countries, as well as in the Czech Republic, Hungary, the Netherlands, Slovakia, and Spain.

Libya has been politically isolated for the past 15 years. Limited exploration activities and development activities have shown promise in the past few years. Without sufficient foreign investment, however, the much-needed enhanced recovery operations in older fields will limit petroleum output and, thus, the economy of Libya.

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TABLE 1
LIBYA: PRODUCTION OF MINERAL COMMODITIES 1/

(Thousand metric tons unless otherwise specified)

Commodity 2/	1994	1995	1996	1997	1998 e/
Cement, hydraulic	3,800 r/	3,210	3,550	2,524 r/	3,000
Gas, natural:					
Gross million cubic meters	12,510 3/	12,460 3/	12,640 3/	12,910 3/	13,000
Dry do.	6,390 3/	6,345 3/	6,420 3/	6,570 3/	6,650
Gypsum e/	180	160 r/	175 r/	125 r/	150
Iron and steel:					
Metal:					
Direct-reduced iron	852	963	862	990	1,200
Crude steel	874	909	863	897	925 3/
Lime e/	260	260	260	275	275
Nitrogen:					
N content of ammonia	350	534	545	536	540
N content of urea	347	409	399	383	385
Petroleum:					
Crude thousand 42-gallon barrels	507,313	509,175	511,000	516,475	502,970 3/
Refinery products:					
Gasoline do.	16,000	15,500	16,000	16,200	16,200
Kerosene and jet fuel do.	13,800	13,700	14,200	14,300	14,300
Distillate fuel oil do.	29,600	29,000	31,400	31,500	31,500
Residual fuel oil do.	32,500	32,000	35,400	35,500	35,500
Other do.	10,200	10,500	18,000	18,000	18,000
Total do.	102,100	100,700	115,000	115,500	115,500
Salt	30	30	30	30	30
Sulfur, byproduct of petroleum and natural gas e/	13	13	13	13	13

e/ Estimated. r/ Revised.

1/ Table includes data available through December 1, 1999.

2/ In addition to the commodities listed, a variety of brick, construction stone, and tile was produced, but available information was inadequate to make reliable estimates of output levels. Natural gas liquids were also produced but were blended with crude petroleum and were reported as part of that total.

3/ Reported figure.

THE MINERAL INDUSTRY OF MADAGASCAR

By George J. Coakley

The Republic of Madagascar, the world's fourth largest island, is about 420 kilometers (km) east of Mozambique in the Indian Ocean and has an area of 581,540 square kilometers (km²). The area supported a population of 14.6 million in 1998, with a gross domestic product per capita of \$730 based on 1997 purchasing power parity data. Mineral production played a secondary role to agriculture and fishing in the economy of Madagascar. Coffee and vanilla accounted for about two-thirds of total exports of \$518 million in 1997. The Malagasy mining industry was chiefly noted for its production and export of chemical- and metallurgical-grade chromite ore, high-quality crystalline flake graphite, and mica. In addition to these minerals, small quantities of gold and rare earths were produced, along with some other industrial mineral commodities, including cement, feldspar, a variety of semiprecious gemstones, quartz, and salt. In recent years, active exploration on the island has targeted sapphires and other semiprecious gemstones, gold, nickel, and titanium. Undeveloped deposits of bauxite at Manantenina, iron ore at Soalala, and coal at Sakoa also occurred on the island nation. Production of refined petroleum from imported crude remained modest, and exploration for hydrocarbon resources continued. The Government had nationalized all mineral resources, with the exception of graphite and mica, in 1975.

Legislation controlling investment and mining in Madagascar included the Investment Code, law No. 85-001 and the Mining Code, law No. 90-017 of 1990, which revised and augmented law No. 89/007 of December 12, 1989. A scheduled revision of the 1990 mining permits code had yet to take place despite the rejection of the current mining code by operators in 1994. The Malagasy Parliament passed a new petroleum law in 1995, an English summary of which is available in the 1996 International Petroleum Encyclopedia (PennWell Publishing Co., 1997). During 1998, a new mining law was being prepared for presentation to the National Assembly in 1999, along with a new legal framework policy to promote new foreign investment in projects exceeding \$200 million.

Two major nickel and titanium deposits have been identified in recent years, with future development pending favorable market and investment conditions. QIT-Fer et Titane Inc., a Canadian subsidiary of Rio Tinto plc of the United Kingdom, has held the rights to the titanium-bearing minerals sands deposit in the Fort Dauphin region of southern Madagascar since 1987. During 1998, Phelps Dodge Corp. of the United States completed a feasibility study examining the development potential of its nickel laterite deposit in Ambatovy, central Madagascar, 80 km east of Antananarivo, which it outlined during exploration in 1996 and 1997. Detailed drilling in the district, which is located 80 km east of the capital city of Antananarivo, defined a resource of 210 million metric tons (t) at 1.1 % nickel and 0.1 % cobalt. Acid consumption by the ore is low, and the ore is amenable to high-pressure acid leach

extraction for nickel and cobalt. The feasibility study indicated that there was a need for the price of nickel to increase to make the project economical (Phelps Dodge Corp., 1999, Annual report for 1998, accessed January 22, 2000, through U.S. Securities and Exchange Commission at URL <http://www.sec.gov/Archives/edgar/data/78066/0000950147-99-000246.txt>).

The Government continued to seek multilateral and bilateral cooperation to aid in controlling the degradation of the environment incurred during the past few years. Uncontrolled slash-and-burn cultivation, deforestation, livestock overgrazing, and massive erosion threatened Madagascar's agricultural and hydroelectric potential and the country's unique wildlife.

Detailed production statistics were not readily available. However, estimates for 1998, based on historical levels for all mineral commodities, are listed in table 1. Mineral exports, with the exception of mineral samples associated with exploration, must be authorized by the Ministry of Energy and Mines (MEM). Smuggling of undocumented gold and semiprecious stones out of the country remained a problem. The MEM formed a new gold trading agency in 1995 in an attempt to increase the Government's share of revenue from gold production and trade. The Government's official gold export statistics have ranged from 37 kilograms (kg) in 1992 to less than 1 kg in 1993; actual production and illegal export of gold in recent years may range from 500 kilograms per year (kg/yr) to as much as 3,000 kg/yr. This illegal trade was of concern to the Government, which has sought cooperation from neighboring nations, such as Mauritius, to help interdict gold smuggling.

Madagascar imported essentially all its crude petroleum and some petroleum products, which was a significant burden to the economy. In any given year, the value of petroleum imports was equivalent to 15% to 30% of the total foreign exchange earned from all export revenues.

The chromite industry, located in Andriamena, was controlled by the parastatal Société Kraomita Malagasy (KRAOMA). Graphite and mica production were owned and operated by foreign entities, but the Government had significant influence on these operations through taxes, royalties, and official approval of all foreign exchange transactions.

Office des Mines Nationales et des Industries Stratégiques (OMNIS), created in 1976, was involved primarily in research, joint ventures, and promotion of Madagascar's mineral resources, including hydrocarbons, and acted as the repository of the acquired exploration data. The MEM, through the Directorate of Energy, had primary responsibility for the energy sector. The MEM also directed Solitary Malagasy (SOLIMA) and the Electricity and Water Co. The distribution, importation, and refining of petroleum products were managed by SOLIMA.

KRAOMA reported chromite ore production of 140,000 t in 1998 comprising 40,000 t of concentrates and 80,000 t of lumpy ore from the Andriamena Mine and 20,000 t of fines from the

Behandrinana Mine. KRAOMA ships 10,000 t of ore by rail from Morarano station and 4,000 t by truck monthly to Toamasina port. KRAOMA reported chromite ore exports of 120,000 t in 1998 (TEX Report, 1998).

Madagascar had some scattered placer and lode gold deposits, and a large black market reportedly existed for the mining and sale of gold. Gold mining was primarily artisanal and employed approximately 5,000 to 10,000 people. In 1997, Riosun Resources Corp. of Canada acquired the gold mining interests in northern Madagascar of Glamorgan Group Ltd.

The artisanal gemstone mining sector was active but largely uncontrolled and had known but unreported production of emeralds, sapphires, and other semiprecious stones. As with gold, proposed Government efforts to organize and regulate these small-scale mining activities will have the potential to increase formal export earnings and the Government tax base significantly. However, the artisanal working of sapphire deposits in the Ankarana Special Reserve and other environmentally sensitive areas had raised both local and international concerns over damage to the environment.

During 1997, Riosun Resources Corp. acquired an 80% interest in Export-Import Madagascar (Eximad) S.A.R.L., which operated the Toby Steven emerald mine in the southern part of the country. A description of the geologic setting of the emerald and sapphire deposits of southern Madagascar was reported by the Bureau de Recherches Géologiques et Minières of France (Bureau de Recherches Géologiques et Minières, 1996). Both gemstones are found in structurally controlled deposits in crystalline schists. The emerald deposits at Andonabe, Anapera, and Beandry were associated with amphibolite facies biotite gneisses and amphibolites of the early Proterozoic Vohibory System, and the sapphire deposits at Analalava, Andranondambo, Ankazoabo, and Anterimena in the south were associated with granulite facies cordierite and biotite gneisses, marbles, and pyroxenites of the Archean Androyen System.

Madagascar continued to be a producer and exporter of high-quality crystalline flake graphite, with production levels running between 12,000 and 13,000 metric tons per year (t/yr) from 1996 to 1998. Graphite was produced in Madagascar by five main companies, all headquartered in Antananarivo. Société Minière de la Grande Ile's (SMGI) Ambatomitamba graphite mine was the largest single producer, processing around 4,000 t/yr of 92% flake graphite. The other four operators were Etablissements Gallois, Société Louys, Etablissements Izouard, and Etablissements Rostaing. Three mines, with production of about 6,000 t/yr of graphite with a carbon content of 90% to 95% were operated by SMGI. SMGI was 100% owned by the French company, Société Participation Industrielle et Minières, which also owned Société des Mines d'Ampandrandava's two phlogopite mica mines at Ampandrandava and Sakamasy.

Madagascar was essentially entirely dependent on imports of crude petroleum to meet its energy needs. Total petroleum consumption averaged about 26 million barrels per year. During the past several years, the amount of oil exploration by foreign companies in Madagascar has been modest. No significant commercial hydrocarbon finds have, however, been reported (Mbendi Information Services, August 13, 1997, Madagascar oil industry profile, accessed March 29, 1998, at URL <http://mbendi.co.za.cymdoi.htm>). In 1997, Gulfstream Resources Canada Ltd. acquired an 82% interest in the 26,700-km² Tsiribihina Block in the Morondava onshore basin and an

80% interest in the 5,200-km² Antonibe Block in the Majunga offshore basin. A 300-km seismic program in 1997 was followed by a multiwell drilling program in 1998. Several wells were drilled in the target area, one of which had an estimated 56.6 billion cubic meters of natural gas in place (Gulfstream Resources Canada Ltd, June 30, 1997, Gulfstream accelerates activity in Madagascar, accessed May 15, 1998, at URL <http://www.gur.com/pressrel.html#30/06/97>). In July 1997, Triton Energy Limited of the United States acquired the 28,170-km² offshore Ambilobe Block in the north and a 27,520-km² onshore property at the southern tip of the island.

Madagascar had production from its resources of chromite, graphite, and mica and had known deposits of bastnaesite (a rare-earth mineral), bauxite, ilmenite, iron ore, and nickel. Resources of gold and semiprecious gemstones were exploited at the artisanal level, but the economics of exploiting them as medium- to large-scale mining operations were undetermined. Deposits of coal, lignite, and uranium minerals also were known.

Infrastructure development in Madagascar was inadequate for most mining development. Additional investment was needed to improve the road system and the telecommunications network. The hydroelectric potential of Madagascar was estimated to be 14,000 megawatts (MW) but remained underexploited. In 1998, installed hydropower capacity was 106 MW. Petroleum loading and unloading facilities were at Toamasina/Tamatave but were limited to oceangoing vessels of 50,000 deadweight tons. World Bank and International Monetary Fund economic stimulus programs were implemented to accelerate the Government's liberalization and privatization efforts and to create the economic and legal environment needed to attract foreign investment in the mining, energy, and other sectors. Increasingly strict environmental protection concerns, such as those that resulted from titanium sands mining proposals and recent illegal artisanal sapphire mining, may serve to inhibit new capital investment in the mining sector, at least in the short term.

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TABLE I
MADAGASCAR: PRODUCTION OF MINERAL COMMODITIES 1/

(Kilograms unless otherwise specified)

Commodity 2/	1994	1995	1996	1997	1998 e/
METALS					
Beryllium, beryl in quartz concentrates, industrial and ornamental e/	3,000	31,666 3/	32,000	32,000	32,000
Chromium:					
Chromite concentrate, gross weight metric tons	42,700	49,702	54,900	55,900	60,000
Chromite ore, lumpy do.	47,500	56,405	82,300	83,800	80,000
Total do.	90,200	106,107	137,200 3/	139,700 3/	140,000 3/
Gold, mine output, Au content e/ 4/	500	38 3/	50	50	50
INDUSTRIAL MINERALS					
Abrasives, natural (industrial only) e/	10,000	10,000	10,000	10,000	10,000
Cement, hydraulic e/ metric tons	40,000	40,000	80,000	120,000	120,000
Clay, kaolin e/ do.	700	1,545 3/	1,500	1,500	1,500
Feldspar e/	4,000	2,120 3/	2,000	2,000	2,000
Gemstones: e/ 5/					
Amazonite	2,000	2,000	2,000	2,000	2,000
Amethyst:					
Gem	1,700	1,700	1,700	1,700	1,700
Geodes	80	80	80	80	80
Graphite, all grades, shipments metric tons	14,593 r/	16,119	12,134 r/	13,975 r/	13,000
Mica, phlogopite: e/					
Block do.	4	1	1	1	1
Scrap do.	300 r/	389	400 r/	582	550
Splittings and sheet do.	52 r/	42	49 r/	21	49
Total do.	356 r/	432	450 r/	603	600
Ornamental stones: e/ 6/					
Jasper	68,000	68,000	68,000	68,000	68,000
Labradorite	61,000	61,000	61,000	61,000	61,000
Quartz: e/ 7/					
Crystal	32,000	32,000	32,000	32,000	32,000
Piezoelectric	66,000	66,000	66,000	66,000	66,000
Rose quartz	27,000	27,000	27,000	27,000	27,000
Smelting	180,000	180,000	180,000	180,000	180,000
Salt, marine e/ metric tons	75,783 r/	51,307 r/	50,000	50,000	50,000
Stone: e/					
Calcite, industrial do.	2,000	2,000	2,000	2,000	2,000
Dimension stone do.	3,000	3,000	3,000	3,000	3,000
Marble, cipoline	1	1	1	1	1
MINERAL FUELS AND RELATED MATERIALS					
Petroleum refinery products: e/					
Gasoline thousand 42-gallon barrels	225 3/	200 r/	200 r/	200	200
Kerosene and jet fuel do.	100 3/	85 r/	85 r/	85	85
Distillate fuel oil do.	70 3/	60 r/	60 r/	60	60
Residual fuel oil do.	125 3/	100 r/	100 r/	100	100
Other do.	5 3/	5 r/	5 r/	5	5
Total do.	525 3/	450 r/	450 r/	450	450

e/ Estimated. r/ Revised.

1/ Includes data available through April 1998.

2/ In addition to the commodities listed, modest quantities of unlisted varieties of crude construction materials (other clays, sand and gravel, and stone) presumably were produced, but output was not reported quantitatively, and available information was inadequate to make reliable estimates of output levels.

3/ Reported figure.

4/ Does not include an estimate of smuggled artisanal production.

5/ Reported output of other gemstones for 1996, in kilograms: cordierite, 3,942; garnet, 31,607; and tourmaline, 176,256. Most emerald and sapphire production was unreported.

6/ Other ornamental stones produced in 1996 for which data were reported, in kilograms: agate, 9,335; apatite, 16,982; aragonite, 569; calcite, 43,419; ruby, 48,194; and sapphire, 94.

7/ Other forms of quartz mined historically and estimated production, in kilograms: geodes, 2,500; hematoid, 300; and other ornamental quartz, 3,000.

THE MINERAL INDUSTRY OF

MALAWI

By George J. Coakley and Philip M. Mobbs

The Republic of Malawi is a landlocked country surrounded by Mozambique, Tanzania, and Zambia. It has an area of 119,140 square kilometers, of which 20% is Lake Malawi. In 1998, Malawi had a population of about 10.5 million and a gross domestic product (GDP) estimated by the World Bank to be \$1.7 billion, down from an estimated \$2.5 billion in 1997 (World Bank, September 20, 1999, Malawi at a glance, accessed November 26, 1999, at URL <http://www.worldbank.org/data/country/countrydata.html>). The mineral sector contributed modestly to the agriculture-based economy.

Cement, coal, crushed stone for aggregates, dolomite, limestone, and some salt (artisanal) were produced and consumed locally. (See table 1.) Malawi also produced small amounts of lime. Production of semiprecious gemstones, included, in order of volume, rubies, sapphires, aquamarine, amethyst, garnet, and agate. Coal from the Mchenga Mine and limestone produced in Malawi were essential components of the country's cement and lime industries. The production of stone for aggregate and cement was the largest component, by value, of Malawi's mineral production.

The country has known mineral deposits of apatite, aquamarine, bauxite, corundum, glass sand, granite, graphite, kaolin, kyanite, monzanite, phosphate, pyrite, salt, tourmaline, uranium, and vermiculite. Resources of oil or natural gas are not known (Ministry of Energy and Mining, 1997).

In 1998, Anglo American Corp. of South Africa obtained an option to earn 70% equity interest in the eight gold exploration properties of Castle Exploration Inc. of the United States. At yearend, Castle was merging with Santa Cruz Gold Inc. of Canada. Industrix Co. was reported to be examining the Chimutu graphite deposit (L.S.N. Kalindekafe, Ministry of Energy and Mining, written commun., 1998). Caledonia Mining Corp. of Canada maintained its prospecting license for the Kangankunde rare-earths deposit. Paladin Energy Minerals NL of Australia, a subsidiary of Paladin Resources NL, acquired 80% equity interest in the Kayelekera uranium prospecting license from Balmain Resources Pty. Ltd. of

Australia. Paladin was reevaluating the prospect, 40 kilometers west of Karonga, which had been the subject of a feasibility study by the Central Electricity Generating Board of Great Britain in 1990. Other companies exploring in Malawi included Zambezi Exploration Pvt. Ltd. and Consolidated Diamonds Mining Co.

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TABLE 1
MALAWI: PRODUCTION OF MINERAL COMMODITIES 1/ 2/

(Metric tons unless otherwise specified)

Commodity 3/		1994	1995	1996	1997	1998 e/
Cement, hydraulic		121,954	138,675	91,000 r/	175,800	175,000
Coal		34,630	14,635	69,930	63,210	65,000
Dolomite		1,321	876	700 e/	700 e/	700
Gemstones, ruby and sapphire	kilograms	21,454	75,588	100,000 e/	351	350
Lime		3,544	1,119	3,150	1,940	2,000
Stone:						
Crushed for aggregate	cubic meters	65,039	65,601	58,700	162,538	160,000
Limestone, for cement		173,758	175,578	133,648	258,000	260,000

e/ Estimated. r/ Revised.

1/ Estimated data are rounded to three significant digits.

2/ Table includes data available through December 7, 1999.

3/ In addition to commodities listed, modest quantities of unlisted varieties of crude construction materials (clays, sand and gravel, and other stone) may also be produced, but information is inadequate to make reliable estimates of output levels.

THE MINERAL INDUSTRY OF

MALI

By Philip M. Mobbs

Gold was the most economically significant mineral commodity produced in Mali during 1998. Gold production from the Sadiola Hill Mine, the Syama Mine, and artisanal production reached an estimated 25 metric tons. Mali was tied for third with Zimbabwe on the list of African gold producers, after South Africa and Ghana. Despite 1998 being a difficult year for mining companies to raise capital, gold exploration continued during the year in the Birimian Series greenstone belts in the southern and southwestern parts of the country.

The gross domestic product (GDP) of landlocked Mali was \$2.5 billion in 1997, the latest year for which data are available. The agriculture sector contributed nearly 50% to the GDP. Gold accounted for about 36% of the country's 1997 exports of \$562 million.

Mining was overseen by the Direction Nationale de la Géologie et des Mines, which is part of the Ministère des Mines, de l'Energie et de l'Hydraulique. The mining code included Decree No. 96-214/PM-RM of August 16, 1996, Ordonnance No. 91-065/P-CTSP of September 19, 1991, Decree No. 91-277/PM-RM of September 1991, and Decree No. 91-278/PM-RM of September 1991. The Government had the right to a 20% equity in all new mining ventures, of which 10% was a free share and the remainder, a buy-in option. Net profits were taxed at the rate of 35% after a 5-year exemption period. The ad valorem tax was 3%, and the depletion allowance was as high as 27.5%. Petroleum exploration and exploitation were regulated by Decree No. 30 of May 23, 1969, and by Decree No. 21 of April 20, 1970.

The Société d'Exploitation des Mines d'Or de Sadiola, S.A. (Semos), operated the open pit Sadiola Hill Mine, about 80 kilometers (km) southwest of Kayes in western Mali. Semos was a consortium of Anmercosa Mining (West Africa) Ltd. (38%), a subsidiary of AngloGold Ltd. of South Africa (formerly part of Anglo American Corp. of South Africa); AGEM Ltd. of Barbados (38%), a subsidiary of International African Mining Gold Corp. of Canada; the Government of Mali (18%); and the International Finance Corp. (IFC) (6%), a member of the World Bank Group. In 1998, 10.3 million metric tons (Mt) of material were mined and 4.9 Mt of oxide ore were milled. Mill operations again exceeded the plant's design capacity of 4 million metric tons per year (Mt/yr). The mine produced 15,742 kilograms (kg) of gold, reported as 506,113 troy ounces (Northern Miner, 1999).

The Malian gold rush continued during 1998; however, a number of companies reduced or terminated their exploration efforts and spent as much or more effort searching for funding or joint-venture partners. Companies active on gold exploration permits along the western border with Senegal in the area encompassing the Kénédiéba gold district and the exploitation permits at Loulo and Sadiola included Afko Corp. Mali, a

subsidiary of Afko Korea Inc., on a Kénédiéba area property and African Goldfields Corp., a subsidiary of African Selection Mining Corp. of Canada, on the Kofi and the Metedia Est concessions. Exploration on the Djlimagara property continued as AngloGold (42.5%) joined the venture of Barrick Gold Corp. of Canada (42.5%) and the Government (15%). Emerging Africa Gold (EAG) Inc. of Canada explored the Mankouke West, the Kourou, and the Siribaya permits. The joint venture of Emerging African Gold (75%) and Geo-L of Russia (25%) held the Koulo permit. Golden Eagle Mining Ltd. was earning a percentage of African Selection Mining's interest in the Farina, the Gori, the Kanbele Est, the Kofi, the Metedia Est, the Metedia Sud, the Netekoto, and the Satifara concessions.

International Tournigan Corp. of Canada was soliciting for partners to fund further exploration on its Malian properties, including the Kolomba and the Mogoyafara properties held in joint venture with Société Nationale de Recherches et d'Exploitation des Ressources Minières de Mali and the Diangounte West property. MaliCan of Mali acquired the Dag Dag permit from Echo Bay Mines Ltd. of Canada. Marchmont Gold Corp. of Canada discontinued exploration of the Sitakili permit. The prefeasibility study for the Tabakoto concession was completed for NevSun Resources Ltd. of Canada and its operating subsidiaries NevSun Resources (Mali) Ltd. of Barbados and NevSun Mali Ltd. of the British Virgin Islands. Project cost was estimated to be \$74 million (NevSun Resources Ltd., 1999, p. 14). NevSun, in joint venture with Le Groupement D'Intérêt Economique des Orpailleurs de Dioulafoundouding, was working the Dioulafoundouding concession. NevSun restricted its exploration activity on the Kakadian concession and was earning a 75% interest in the Satifara concession from African Selection Mining. NevSun's proposed purchase of the Dar Salam and the Segala concessions from Oliver Gold Corp. of Canada and Consolidated Mining Corp. (West Africa) S.A. of Mali (CMCWA), a subsidiary venture of Trillion Resources Ltd. of Canada (51%) and Consolidated Mining Corp. of South Africa (29%), was not realized.

The joint venture of North Ltd. of Australia and Randgold Resources Ltd. of the United Kingdom, a subsidiary of Randgold & Exploration Co. Ltd. of South Africa, was exploring the Yanifolila permit. Pan African Resources Corp. of Canada, a subsidiary of Golden Star Resources Ltd. of Canada, relinquished the Fougala and the Melgue properties. Doing business as Dialafara Exploration S.A., Randgold Resources (Mali) Ltd., a subsidiary of Randgold Resources, and Leo Shield Exploration NL of Australia drilled the Dialafara permit. Leo Shield subsequently withdrew from the venture. Leo Shield also relinquished its interest in the Dialafara-Khama, the Karouma, and the Kouroufing concessions. Randgold

secured an option to earn a 60% interest in the Médinandi and Dandoko gold properties from Western African Gold and Exploration Co. S.A., a subsidiary of Sanou Mining Corp., which would retain a 20% interest in the properties. Azco Mining Inc. of the United States, West African Gold & Exploration Ltd. of the British Virgin Islands, and Eagle River International Ltd. controlled Sanou. The Government also held 20% interest in the prospects.

Also working in the Kéniéba region was Raymor Resources Ltd. of Canada, earning 85% interest in the Yeremounde gold property from Compagnie de la Falame S.A. (Comifa) of Mali. A Comifa and Raymor joint venture was examining several of the Comifa exploration permits. The joint venture of Ressources Robex Inc. of Canada (85%) and N'Gary Transport of Mali (15%) drilled the Diangounté and the Kata concessions. Ressources Robex (25%) continued exploration of the Baroya concession for its joint-venture partners, Shiega Resources Corp. of Canada (65%), and SOMEX S.A.R.L. of Mali (10%). Robex was negotiating to acquire Shiega's interest in the property at yearend. The Société Minière de Loulo S.A., a joint venture of Randgold (51%), Mine Or, S.A., of France (29%), and the Government (20%) continued exploration on the Loulo permit. Randgold postponed the feasibility study of the proposed 9-year heap-leaching project to develop the Loulo prospect's measured, indicated, and inferred gold resources of 30.6 Mt grading 3.5 grams per ton (g/t) gold with a cutoff grade of 1.5 g/t. The postponement was because Randgold shifted its interest to the Morilla concession at midyear (Randgold Resources Ltd., [undated], Loulo Project, accessed June 2, 1999, at URL

<http://www.geocities.com/~polarbear47/loulo.htm>).

Sadiola Exploration Ltd. of the British Virgin Islands (SADEX), a joint venture of AngloGold (50%) and Iamgold Corp. of Canada (50%), attributed a resource of 2 Mt of oxide ore grading 2.5 g/t gold with a 1.0 g/t cutoff grade to the Alamoutala deposit, about 15 km north of Sadiola. SADEX explored the Kourketo West deposit; completed the acquisition of the Yatela concession from Etlin Ltd. of Australia, 25 km north of the Sadiola Mine; and began a feasibility study of the Niamboulama deposit on Yatela in 1998.

The Société des Mines d'Or de Syama S.A. (Somisy), operated the open pit gold mine at Syama, 75 km southwest of Sikasso in southern Mali. Somisy was owned by Randgold Minerals (Mali) Inc. (75%), the Government of Mali (20%), and the IFC (5%). To increase the plant capacity, Somisy completed a \$63 million upgrade of the facility, including the installation of a new crusher, a new flotation circuit, a pre-owned ball mill, and a second-hand semiautogenous mill. In 1998, 14.1 Mt of material was mined, and 1.3 Mt of sulfide ore was milled. The mine produced 4,486 kg of gold in 1998. A \$11 million, 1.6 Mt/yr heap-leaching project to treat stockpiled low-grade ore was under construction at Syama. Gold resources at Syama were reported as 61.55 Mt of ore grading 3.38 g/t gold (Mining Magazine, 1999).

Companies evaluating gold exploration permits in the Kalana, the Kangaba, and the Syama regions in southern Mali included the joint venture of AngloGold, Barrick Gold, and the Government exploring the Finkalo and the Misseni properties; Carlin Resources Corp. of Canada, which relinquished its option on the Alagona Trading S.A.R.L. permit in 1998; and

Mink International Resources Corp. of Canada. The venture of Nelson Gold Corp. Ltd. of Canada (70%), the Government (20%), and Ashanti Goldfields Co. Ltd. of Ghana (10%), was negotiating to reopen the former Kalana underground gold mine. Nelson Gold revised its 1997 feasibility study in January 1998 to account for the drop in the price of gold during 1997.

Oxford Resources Inc. of Canada proposed to expand its exploration activity in Mali and supported its local partners applications for several additional gold prospecting permits. Pangea Goldfields Inc. of Canada terminated its exploration of the Fodié and the Foulaboula prospects and was interested in divesting its interest in the properties. Prospector International Resources Inc. of Canada (formerly Pacific Galleon Mining Corp.) relinquished its concession in Mali.

In 1998, Prospex Mining Inc. of the United States acquired, mapped, and sampled the Samalofila gold property. Randgold completed its prefeasibility study of the Morila permit. Development of the prospect's resources of 33 Mt of ore grading 4.22 g/t gold was estimated to cost \$80 million, and a full feasibility study was begun at midyear (Mining Magazine, 1999). Randgold acquired the option to earn 65% interest in the Sélou property of Oxford. Sahelian Goldfields Inc. of Canada evaluated the Kourémalé-Salémalé property.

North of the former Kalana Mine, the Société pour le Developpement des Investissements en Afrique S.A. of Mali was developing the Kodieran permit and Young Poong Mining and Construction of South Korea was evaluating the Gouenso gold concession. In northeast Mali, Taghilit S.A. of Mali, owned in part by CMCWA and Oliver Gold, was exploring the Anéfis and In Darset gold exploration permits.

Current diamond production in Mali was a byproduct of artisanal gold mining. The Mali Diamond Exploration B.V. joint venture of Ashton West Africa Pty. Ltd. of Australia (51% interest) and Mink International Resources Corp. of Canada (49%) discovered another six kimberlites and continued a drilling program on their Kéniéba area diamond prospect.

Stratic Energy Corp. of Canada reprocessed existing seismic data that covered its three petroleum exploration leases in Mali.

Mali's transportation infrastructure was underdeveloped. The highway network totaled about 15,700 km, mostly in the south. The 1,286-km railroad connecting Bamako with Dakar, Senegal, and the major roads to Côte d'Ivoire were used to import mineral-related products, particularly fuels, as well as equipment and supplies.

The country had a wide variety of other mineral occurrences including barite, bauxite, copper, diatomite, granite, iron, lead, limestone, lithium, manganese, marble, nickel, peat, and zinc, but few have been developed because of the condition of the nation's transportation network and lack of local demand (United Nations, 1987). The gold rush and anticipated development activity will continue to strain Mali's transportation and electrical power systems. Gold, despite the price drop in 1998, will likely continue to dominate the country's mineral economy. Current exploration efforts could lead to development of additional gold deposits by the turn of the century.

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 ———[undated], All about mining operations in Mali: Bamako, Ministère des Mines, de l'Energie et de l'Hydraulique, 23 p.
 Direction Nationale de la Géologie et des Mines, 1996, Gold in Mali—A new investment opportunity: Bamako, Direction Nationale de la Géologie et des Mines, 4 p.

TABLE 1
 MALI: ESTIMATED PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity 2/		1994	1995	1996	1997	1998
Cement, hydraulic		15,000	13,000	12,000	10,000	10,000
Gold, mine output, gold content 3/	kilograms	6,200	7,800	8,400	19,000	25,000
Gypsum		500	450	500	100	500
Iron	kilograms	--	69	--	--	--
Phosphate		1,039	3,000	--	--	--
Salt		5,000	5,000	6,000 r/	5,000	6,000
Silver 4/	kilograms	200	250	270	800	900

r/ Revised.

1/ Includes data available through July 1999.

2/ In addition to the commodities listed, Mali produced clays, stone, and sand and gravel for local construction purposes in addition to diamond, marble, and tin, but information is inadequate to make reliable estimates of output levels.

3/ Includes estimate of artisanal production.

4/ Estimated silver content of doré bullion.

THE MINERAL INDUSTRY OF

MAURITANIA

By Bernadette Michalski¹

Iron ore mining and beneficiation dominated the mineral industry in Mauritania and accounted for more than 11% of the gross national product and about 40% of export revenues. Cement, gypsum, plaster, and salt also were produced. The nation's sole petroleum refinery, operating on imported crude oil, supplied most of the country's petroleum product requirements. Exploration programs accelerated during 1998. Principal activities focused on diamond exploration in the north; gold exploration in the Tassia, Tijirit, and Inchiri regions, as well as along the Mali border in the south; and offshore oil exploration.

The Direction des Mines et de la Géologie implements Government policies for developing the mining sector, as well as supervises the semipublic mining companies. Government equity participation in these companies ranges from 40% to 77%.

Mining interests are protected under the Investments Code (1989), the Mining Code of 1977 (updated in 1988 and 1998), and the Petroleum Code (1988). The legal framework is largely based on French law and regulations. The investment and mining codes were updated in 1998, creating favorable incentives for foreign investments throughout all stages of project development. Incentives included custom duty and tax exemption on the import of minerals (including fuel), equipment, and goods to be used in mining and exploration.

Production of the nation's foremost mineral commodity, iron ore, was, for the most part, derived from the M'Haoudat Mine, which provided direct shipping ores averaging 65% iron content. (See table 1.) Salt was recovered from coastal areas near Nouakchott. Production, however, did not meet the heavy requirements of the fish-processing industry.

In 1998, Mauritania exported 11.4 million metric tons (Mt) of iron ore. Nearly one-third of the total was delivered to Italy and a slightly lesser amount to France. The remainder was delivered to Belgium, Germany, and the United Kingdom. Mineral imports include about 7 million barrels of crude oil from Algeria, and from diverse sources, about 125,000 metric tons per year (t/yr) of aluminum and copper semimanufactures, 3,000 t/yr of sulfuric acid, 2,000 t/yr of phosphate fertilizer, and about 12,000 t/yr of salt.

General Gold Resources N.L. of Australia, in partnership with Société Arab des Mines de l'Inchiri, have formed the Guelb Moghrein Mines d'Akjout to develop the Guelb Moghrein gold-cobalt-copper deposit with a minable reserve of 21.7 Mt averaging 1.81% copper, 1.44 grams per ton (g/t) gold, and 0.016% cobalt at a copper equivalent cut-off grade of 1.16%. Reserves should support a 14-year mine life at a planned processing rate of 1.5 million metric tons per year (Mt/yr) of

sulfide ore and 242,000 t/yr of oxide ore according to Kilborn SNC-Lavalin of Canada (General Gold Resources N.L., 1997). Investors are being sought for the \$181 million development program.

Iron ore mining operations were conducted by Société Nationale Industrielle et Minière (SNIM) in the Tiris province in northern Mauritania. More than one-half of the nation's iron ore production is derived from the M'Haoudat deposit, 60 kilometers (km) northeast of Zouirat. In 1998, SNIM invested \$72 million on expansion, nearly double the previous year's investment level. Expansion plans include the construction of an iron ore pelletizing plant to satisfy demands of direct-reduction plants in North Africa. The plant's capacity was planned at 4 Mt/yr of iron ore pellets upgraded to a 68% iron content from an average of 36% iron content. The project involves mining and beneficiation at Ayoudj, 30 km north of F'Derik and 650 km from the port of Nouadhibou. The Alexandria National Iron & Steel Co. and the Holding Co. for Metallurgical Industries, both of Egypt, along with Entreprise Nationale de Siderurgie and Entreprise Nationale de Fer et de Phosphates, both of Algeria, have joined SNIM as partners in the project.

The Rex Diamond Mining Corp. of Canada is prominent in the nation's diamond exploration with three permits covering a total of 71,700 square kilometers in the core of the Archaean Reguibat craton. Sampling began in late 1997 and was expected to be completed by April 1999. The first group of pyrope-rich depressions were underlain by an alluvial gravel layer that was 1 meter (m) thick, 1 km wide, and about 8 km long. During 1998, Rex mobilized a jig plant for testing the diamond content of the alluvial gravel (Mining Journal, 1999).

Mauritania's only petroleum refinery, Nouadhibou, was owned by the Société Mauritanienne d'Industrie de Raffinage and was operated under the technical management of Algeria's Nafta. The 20,000-barrel-per-day-capacity refinery, dependant upon imported crude oil, supplied most of Mauritania's petroleum product requirements.

Mauritania's proven iron ore reserves are 155 Mt of hematite ore ranging from 60% to 68% iron and 531 Mt of magnetite ore ranging from 36% to 40% iron. In addition to these proven reserves, probable iron ore reserves in the western Guelb amount to 980 Mt of low-grade ores. Reserves at the Guelb Moghrein copper mine from surface to 110-m depth are oxide, 1.7 Mt averaging 1.94% copper, 2.40 g/t gold, and 0.031% cobalt, and sulfide, 13.7 Mt averaging 1.81% copper, 1.62 g/t gold, and 0.025% cobalt. Indicated sulfide resources from 110 to 220 m depth at Guelb Moghrein are 10.7 Mt averaging 1.63% copper and 0.93 g/t gold; indicated oxide resources are 0.9 Mt

¹Deceased.

averaging 0.82% copper, 1.54 g/t gold, and 0.016% cobalt (General Gold Resources N.L., 1997).

The nation's limited infrastructure, which renders all but the largest deposits uneconomic, remained a major barrier. There were four paved roads in Mauritania—from the port of Nouakchott to the copper deposits at Akjoujt in the north, from Nouakchott to Nema in the east, from Nouakchott to Rosso in the south, and from Boghe to Kaedi on the southern border. The sole railroad in Mauritania was owned and operated by SNIM for the transport of iron ore from the northern mines to the export terminal. The 1.425-m-standard-gauge railroad extends for 704 km from M'Haoudat to the port at Nouadhibou.

Until recently, most of the nation's known mineral occurrences have not been subjected to serious exploration. However, this situation is changing as a number of exploration permits—particularly for copper, diamonds, gold, and petroleum—have been granted during the past 2 years. The existing and planned mining operations suggest an improved outlook for the nation's economy; it is, however, largely dependent upon world copper, gold, and iron ore prices.

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TABLE 1
MAURITANIA: PRODUCTION OF MINERAL COMMODITIES 1/

Commodity 2/		1994	1995	1996	1997	1998 e/
Cement e/	metric tons	374,000 3/	120,000	100,000 r/	80,000 r/	50,000
Gold	kilograms	1,738	1,196	189	--	--
Gypsum	metric tons	4,230	5,810	12,500	80,000 r/	100,000
Iron ore:						
Gross weight	thousand metric tons	11,400	11,610	11,360	11,700	11,400
Iron content e/	do.	7,000	7,000	7,000	7,000	7,000
Petroleum refinery products: e/						
Liquefied petroleum gas	thousand 42-gallon barrels	415	439	440	440	440
Gasoline	do.	1,925	1,962	1,925	1,925	1,925
Kerosene	do.	470	479	470	470	470
Distillate fuel oil	do.	1,100	1,100	1,100	1,100	1,100
Residual fuel oil	do.	2,355	2,458	2,450	2,450	2,450
Other	do.	640	700	700	700	700
Total	do.	6,905	7,138	7,085	7,085	7,085
Salt e/	tons	5,500	5,500	5,500	5,500	5,500

e/ Estimated. r/ Revised.

1/ Table includes data available through December 1, 1999.

2/ In addition to the commodities listed, modest quantities of crude construction materials (clays, sand and gravel, and stone) presumably were produced, but output was not reported quantitatively and available information was inadequate to make reliable estimates of output levels.

3/ Reported figure.

THE MINERAL INDUSTRY OF MOROCCO AND WESTERN SAHARA

By Bernadette Michalski¹

Morocco and Western Sahara was the world's second largest producer of phosphate rock, following the United States. The nation also had a significant capacity for conversion of phosphate rock into downstream chemicals. Other mineral production included anthracite coal, antimony, barite, cobalt, copper, fluorspar, gold, iron ore, lead, manganese, salt, silver, and zinc. The mineral industry was Morocco's largest foreign-exchange-earning sector and usually accounts for about 35% of foreign trade and about 6% of the gross domestic product.

Although Morocco produced a variety of minerals (table 1), it was phosphate rock and fertilizers production that remain significant on a global scale.

Morocco was the world's foremost exporter of phosphate rock and phosphoric acid; Spain, the United States, and Mexico were the principal phosphate markets by order of volume. Phosphate exports accounted for nearly 31% of Morocco's total exports. Other mineral exports included copper, iron ore, lead, and zinc.

The major mineral commodity import continued to be crude oil and petroleum products. Morocco imports more than 90% of its energy needs. The principal source for imported crude oil was Nigeria and Saudi Arabia. The Islamic Development Bank was the source for financing oil imports (Arab Petroleum Research Center, 1999, p. 281). Algeria was the principal source for liquefied petroleum gas. Other imported mineral commodities included sulfur and coal.

The mining industry of Morocco is controlled by the Government, specifically the Directorate of Mines, which is a department in the Ministry of Energy and Mines. The Directorate of Mines is charged with the interpretation and application of the national mining policy. The Directorate also controls the various parastatals and public companies involved in the mining industry. The state's interests in metal and industrial mineral enterprises are represented by the Bureau de Recherches et de Participations Minières (BRPM). Established in 1928, the BRPM is an autonomous public corporation involved directly or indirectly in the majority of all Moroccan mining enterprises, excluding hydrocarbons and phosphate. Founded in 1920, the parastatal Office Cherifien des Phosphates (OCP) manages and controls phosphate mining. OCP controls all aspects of the phosphate industry in Morocco, including research, exploitation, and the production of derivative products, such as fertilizers. Created in 1960, La Centrale d'Achat et de Développement de la Région Minière de Tafilalet et de Figuig (CADETAF) promotes the working of artisanal mines of barite, lead, and zinc in the regions of Figuig and Tafilalet. CADETAF provides technical, commercial, and social assistance to the artisanal miners. The Government parastatal that controls hydrocarbon exploration and production

is the Office National de Recherches & d'Exploitations Pétrolières.

In the interest of privatization, Government holdings have been successfully reduced, particularly in petroleum refining and metal mining operations. Omnium Nord Africain (ONA), the largest private company in Morocco, acquired much of the Government equity offered for privatization. ONA's mining subsidiary, Pole Mines, was involved in seven significant Moroccan mining ventures. Pole Mines' equity ventures included Compagnie Minière de Guemassa's the Douar Hajar lead mine, the Société Minière de Bou Gaffer's (SOMIFER) Bleida copper mine, the Compagnie de Tifnout Tiranimine's (CTT) cobalt mine at Bou Azzer, the Société Anonyme d'Entreprises Minières's (SAMINE) Meknes fluorite mine; Akka Gold Mining Company's Iourim gold mining venture, Soc. Metallurgique d'Imiter's (SMI) silver mine at Imiter, and Omnium Nord Africain's zinc mine and plant at Guemassa. (See table 2.)

Odyssey Resources of Canada, in agreement with the BRPM, explored for copper 500 kilometers (km) south of Rabat near Alous. The company will carry out all reconnaissance work in the area and will have an acquisition option allowing the company to gain control of properties that return encouraging results (Mining Magazine, 1998).

At the close of 1998, 16 petroleum exploration licenses were in force with 8 foreign companies—Cabre Exploration Ltd. of Canada, Enterprise Oil Exploration plc of the United Kingdom, Lasmo Overseas Nederland (II) B.V., Roc Oil Co. of Australia, Shell Prospecting Africa B.V., Skidmore Energy Inc. of the United States, Taurus Petroleum AB of Sweden, and Vanco Energy Co. of the United States (Middle East Economic Digest, 1998).

Morocco's crude oil production was negligible, but the domestic consumption rate was steadily rising. Crude oil and petroleum product import costs were approximately \$500 million² in 1998, down from nearly \$1 billion in the previous year because of lower oil prices. In 1998, Corral Petroleum AB purchased majority holdings in the 26,000-barrel-per-day (bbl/d)-capacity Sidi Kacem refinery, and in 1997, the 129,000-bbl/d-capacity Mohammedia refinery. Corral, a Swiss-based Saudi Arabian company, pledged to spend \$500 million on renovating and expanding the two refineries. A new company was formed in mid-1998, Corral Morocco Saudi Co., with the purpose of merging the two refineries under that company (Arab Petroleum Research Center, 1999, p. 279).

In 1998, reserves of phosphate rock totaled 85.5 billion metric tons; coal, 17.5 million metric tons (Mt); copper, 8.4 Mt; lead, 23 Mt; and zinc, 8 Mt. Crude oil reserves were reported at 1.95

²Where necessary, values have been converted from Moroccan dirhams (DH) to U.S. dollars at a rate of DH9.86=US\$1.00.

¹Decased.

million barrels and natural gas at 1.4 billion cubic meters. Oil shale reserves were estimated to be 100 billion tons (Arab Petroleum Research Center, 1999, p. 278).

The railroad network in Morocco totaled 1,893 km of 1.435-meter standard-gauge single track. The highway infrastructure totaled 59,198 km, of which 27,740 km was paved. Crude oil and natural gas pipelines totaled 362 km and 241 km, respectively. Morocco's merchant marine fleet comprised 51 ships totaling 487,479 deadweight tons. Of these ships, 3 were petroleum tankers, and 11 were chemical tankers. The major Moroccan ports were Agadir, Casablanca, Jorf Lasfar, Kenitra, Mohammedia, Nador, Safi, and Tangier. The nation's electrical generation capacity was 3,700 megawatts (MW), but the nation planned to increase capacity to 5,574 MW by 2000.

Improving the country's infrastructure, including power generation and transmission, port capacity, and transportation, is a top priority of the Government. Funds for this improvement have recently become available through the transfer of resources from the public sector to the private sector. The Government also signed several agreements with the European Union (EU) on economic cooperation, including the establishment of a free trade zone for industrial goods for a 12-year transition period. The availability of additional capital through membership in the EU will provide further help to bolster the economy.

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Ministère de l'Énergie et des Mines, Direction des Mines
Activité du Secteur Minière 1998, Rabat, Morocco, May 1999.

TABLE 1
MOROCCO AND WESTERN SAHARA: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity 2/ METALS	1994	1995	1996	1997	1998
Antimony concentrate:					
Gross weight	523	442	345	350 e/	350 e/
Sb content	235	198	152 e/	160 r/	160 e/
Cobalt concentrate:					
Gross weight	3,810	4,885	5,033	7,137	2,874
Co content	419	537	565	722	230 e/
Cobalt recovered from tailings	--	--	80	220 e/	220 e/
Copper:					
Concentrates, gross weight	36,010	35,952	37,623	37,344	26,780
Matte, gross weight	1,689	1,933	1,671	2,682	2,841
Cu content, concentrates and matte	14,000	14,100	14,550	15,400	8,200
Gold e/ kilograms	565 3/	580	482 3/	450	450
Iron and steel:					
Iron ore:					
Gross weight	63,517	47,192	11,842	11,965	5,685
Fe content	39,380	31,518	8,257	8,260 e/	3,900
Metal: e/					
Pig iron	15,000	15,000	15,000	15,000	15,000
Steel, crude	7,000	7,000	7,000	7,000	7,000
Lead:					
Concentrate:					
Gross weight	104,520	101,631	107,577	110,507	115,042
Pb content	73,160	67,708	71,667	77,056	79,300
Cupreous matte, Pb content e/	442 3/	500	500	500	600
Metal:					
Smelter, primary only	60,740	62,363	61,749	66,202	65,000 e/
Refined:					
Primary e/	60,700	59,763 3/	62,700	64,202 3/	60,929 3/
Secondary e/	2,040 r/	2,600	3,100 3/	3,000	3,000
Total	62,740 r/	62,363	65,800	67,202	63,929
Manganese ore, largely chemical-grade	31,452	31,263	29,466	28,845	28,332
Silver:					
Ag content of concentrates and matte kilograms	68,500	22,000	19,304	35,000	65,000
Ag content of mine and smelter bullion do.	257,000	182,000	180,291	226,000	241,000
Total do.	325,500	204,000	199,595	261,000	306,000
Zinc concentrate:					
Gross weight	147,213	153,125	152,580	171,796	216,000
Zn content	76,800	79,947	79,662	89,248	112,000
INDUSTRIAL MINERALS					
Barite	264,526	289,308	282,537	338,096	353,438
Cement, hydraulic thousand tons	6,350 e/	6,401	6,585 r/	7,236 r/	7,200 e/
Clays, crude:					
Bentonite	24,919	29,308	39,680	49,633	47,881
Fuller's earth (smectite)	22,800	15,027	17,223	24,425	27,650
Montmorillonite (ghassoul)	3,329	3,311	3,169	2,933	3,180
Feldspar	1,000 e/	17,233	12,659	15,110	5,616
Fertilizers thousand tons	2,000	2,100	2,200 e/	2,200 e/	2,200 e/
Fluorspar, acid-grade	85,000	105,800	95,900	103,800	105,000
Gypsum e/	450,000	450,000	450,000	450,000	450,000
Mica e/	1,500	564 3/	600	600	600
Phosphate rock (includes Western Sahara):					
Gross weight thousand tons	20,375	20,684	20,855	23,084	23,587
P ₂ O ₅ content do.	6,580	6,399	6,552	7,848	7,850
Phosphoric acid do.	2,603	2,600 e/	2,583	2,600 e/	
Salt:					
Rock	142,258	137,910	138,290	210,000 e/	107,604
Marine	45,600	42,300	32,530	47,500 e/	40,000 e/
Talc and pyrophyllite	---	8,429	13,053	19,850	20,000

See footnotes at end of table.

TABLE 1--Continued
MOROCCO AND WESTERN SAHARA: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified.)

Commodity 2/	1994	1995	1996	1997	1998
MINERAL FUELS AND RELATED MATERIALS					
Coal, anthracite	650,400	649,600	505,600	376,300	269,100
Gas, natural:					
Gross million cubic meters	24	25 r/	22 r/	38 r/	43
Dry do.	22	22 r/	20 r/	35 r/ e/	38 e/
Petroleum:					
Crude thousand 42-gallon barrels	62 r/	36 r/	35	35	35
Refinery products: 4/					
Liquefied petroleum gas do.	3,300	2,800 r/	2,000 r/	2,489 r/	2,617
Gasoline do.	3,300	3,000 r/	3,000 r/	3,428 r/	3,548
Jet fuel do.	1,900	1,900 r/	2,000 r/	1,982 r/	2,544
Kerosene do.	390	300 r/	300 r/	481 r/	611
Distillate fuel oil do.	16,200	15,000 r/	14,000 r/	17,800 r/	16,667
Residual fuel oil do.	17,200	12,000 r/	10,000 r/	11,394 r/	12,766
Other do.	7,000	5,800 r/	5,000 r/	6,000	8,517
Total do.	49,290	40,800 3/	36,300 3/	43,574 r/	47,270

e/ Estimated. r/ Revised.

1/ Includes data available through December 1, 1999.

2/ In addition to the commodities listed, a variety of crude construction materials are produced, including, possibly, a substantial amount of limestone; information is, however, inadequate to make reliable estimates of output levels.

3/ Reported figure.

4/ Refinery fuel and losses have been included in the output of individual products and is estimated to be about 1.8 million barrels per year.

TABLE 2
MOROCCO AND WESTERN SAHARA: STRUCTURE OF THE MINERAL INDUSTRY IN 1998

(Metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Anthracite coal	Charbonnages du Maroc (CdM) (Bureau de Recherches et de Participations Minières (BRPM), 98.89%)	Jerada	650,000.
Barite	Compagnie Marocaine des Barytes (COMABAR) (BRPM, 22.5%; Norbar Minerals, 55%)	Zelmou Safi	150,000. 80,000.
Do.	Société Nord Africaine de Recherches et d'Exploitation des Mines d'Argana (SNAREMA)	Argana do.	30,000 chemical grade. 120,000.
Bentonite	Tolsa, SpA (Tolsa, 100%)	Iboughardain	20,000.
Do.	Société d'Exploitation des Mines du Rif (SEFERIF) (BRPM, 100%)	Ouizane- Bouhoua	15,000.
Do.	Compagnie Marocaine des Barytes (COMABAR) (BRPM, 22.5%; Norbar Minerals, 55%)	Azzouzet-Tidiennit	36,000.
Cement	Asment de Temara (Cimentos de Portugal, 57.4%)	Temara	830,000.
Do.	Lafarge Ciments (Société Nationale d'Investissement, 50%)	Casablanca Meknes Tangier	2,000,000. 1,000. 350,000.
Do.	Cimenterie de l'Oriental (CIOR) (Holderbank, 51%; private, 35%)	Oujda Fes	1,000,000. 700,000.
Cobalt	Compagnie de Tifnout Tiranimine (CTT) (Omnium Nord Africain (ONA), 55.2%; SMI, 20%)	Bou Azzer	150,000 ore. 50,000 concentrate.
Copper	Société Minière de Bou Gaffer (SOMIFER) (BRPM, 34.2%, SMI, 36%; ONA, 7.6%)	Bleida	50,000 concentrate.
Do.	Société de Développement du Cuivre de l'Anti-Atlas (SODECAT) (BRPM, 100%)	Tiouit	4,500 Cu, Au, Ag concentrate.
Fluorspar	Société Anonyme d'Entreprises Minières (SAMINE) (ONA, 58%; SMI, 42%)	Meknes	120,000 concentrate.
Gold	Akka Gold Mining Company (ONA, 70%; BRPM, 30%)	Iourim	NA.
Iron ore million metric tons	Société d'Exploitation des Mines du Rif (SEFERIF) (BRPM, 100%)	Nador	12.
Lead	Compagnie Minière de Guemassa (CMG) (ONA, 74%; BRPM, 26%)	Hajar	150,000 Zn concentrate. 32,000 Pb concentrate.
Do.	Compagnie Minière de Touissit (CMT) (Compagnie Royale Asturienne des Mines S.A., Belgium, 50%)	Touissit	73,000 concentrate.
Do.	Société de Développement Industriel et Minière (BRPM, 50%)	Zeida	40,000 concentrate.
Manganese	Société Anonyme Chérifienne d'Etudes Minières (SACEM) (BRPM, 43%; COMILOG, 30%)	Quarzazate	130,000 concentrate.
Petroleum refinery products thousand 42 gallon barrels	Société Marocaine de l'Industrie du Raffinage (Corral Morocco Saudi Co., 100%)	Mohammedia	47,000.
Do. do.	Société Chérifienne des Pétroles (SCP) (Corral Morocco Saudi Co., 100%)	Sidi Kacem	9,500.
Phosphate million metric tons	Office Chérifien des Phosphates (OCP) (Government, 100%)	Yousseoufia Benguerir Khouribga Sidi Chenan BouCraa	6 concentrate. 6 concentrate. 4 concentrate. 5 concentrate. 6 concentrate.
Salt, rock	Société de Sel de Mohammedia (SSM) (BRPM, 100%)	Mohammedia	150,000.
Salt, marine	Société Chérifienne des Sels (SCS) (BRPM, 50%; SNSSS, 50%)	Zima	50,000.
Silver kilograms	Société Metallurgique d'Imiter (SMI) (ONA, 67%; private, 20%; BRPM, 13%)	Near Quarzazate	210,000.
Steel rebar, wire rod	Société Nationale de Sidérurgie (SONASID) (private, 65%)	Nador	480,000.
Zinc	Omnium Nord Africain mine and plant (ONA, 100%)	Guemassa	265,000 concentrate.
Zircon	Agrupacion Minera de Investigaciones S.A.	Guelmin	NA.

NA Not available.

THE MINERAL INDUSTRY OF MOZAMBIQUE

By George J. Coakley

The Republic of Mozambique is located on the southeast coast of Africa and has an area of 749,090 square kilometers. In 1997, the area supported a population of 18.2 million and a gross domestic product (GDP) of \$670 per capita, based on purchasing power parity estimates in 1995. Following nearly 30 years of internal civil strife, which ended with the establishment of a freely elected government in 1994, Mozambique has been striving to rebuild its economy. In 1997, the economy began to show the turnaround hoped for under the rigorous International Monetary Fund and World Bank structural adjustment program that began in the late 1980's—the GDP grew by 14%, inflation was single digit, and export trade increased. The country's high foreign debt load, however, remained a problem.

The minerals and energy sectors played secondary roles to agriculture and fishing in the economy but were the targets for several major new foreign investment proposals. Efforts to rebuild the economy have placed major emphases on mineral-resource development and regional economic integration. By 1997, nearly \$12 billion in new mineral and infrastructure development projects were under consideration by Government and private foreign investors. However, only a few firm project commitments, such as the Mozambique Aluminum Co. (Mozal) project, had been made by 1998. Development plans to date depended heavily on the energy potential of the underutilized Cabora Bassa hydroelectric dam; the Pande, the Temane, and the Buzi natural gasfields; the coal resources at Moatize; and the modernization of the Indian Ocean export harbors at Beira, Maputo-Matola, and Nacala and associated transportation infrastructure. In the metals sector, work began in 1998 on a \$1.3 billion aluminum smelter, and studies were underway to determine the feasibility of developing a second aluminum smelter and major coal, iron, and titanium projects. Resources of dimension stone, gemstones, gold, niobium, petroleum, phosphates, rare-earth minerals, and tantalum were also known (Mozambique Ministry of Mineral Resources and Energy, 1995). Mozambique continued to be an important source of labor for the South African gold industry, with about 60,000 Mozambican miners employed in the Witswatersrand gold mines. Repatriated wages from this workforce provided a significant contribution to the Mozambican economy.

The national mining and petroleum policy was directed at promoting foreign investment and exports, thus increasing the supply of raw materials for domestic industries and minimizing direct Government participation in mineral activities. The minerals industry is regulated by the Mining Law No. 2/86 of April 16, 1986, as amended by Law 5/94 of September 18, 1994, and by the Mining Law Regulations (Decree 13/87 of February 24, 1987). The mining law is administered by the Minister of Mineral Resources and Energy through the National

Directorate for Mines. Tax and other fiscal matters for the mining sector are regulated by the Mining Tax Code (Decree 53/94 of November 9, 1994). Petroleum rights and licensing are regulated by the Petroleum law (Decree No. 3/81) of 1981. Under this law, the national oil company, Empresa Nacional de Hidrocarbonetos (ENH), has statutory responsibility for the exploration and development of natural gas and petroleum resources and can enter into joint ventures and other forms of contractual relations with private companies. Petroleum licensing usually takes the form of a production-sharing agreement with ENH, and natural gas exploration and development takes the form of profit-sharing joint ventures.

The mining industry was chiefly noted for its production and export of bauxite, bentonite, gemstones, graphite, and marble. In addition to these minerals, small quantities of gold along and some industrial mineral commodities, including cement, marine salt, and sand and gravel were produced. Mineral commodity production, as reported by the Ministry of Mineral Resources and Energy, is listed in table 1. Official exports were dominated by bauxite, gemstones, graphite, and marble.

Commodity Review

Metals

Aluminum.—Construction of the Mozal aluminum smelter, 17 kilometers (km) west of Maputo, began in July 1998 with production expected to start up by mid-2000. Mozal was a joint venture of Billiton Plc of the United Kingdom (47%), Mitsubishi Corporation of Japan (25%), the Industrial Development Corporation of South Africa (IDC) (24%), and the Government of Mozambique (4%). The 245,000-metric-ton-per-year (t/yr) aluminum smelter was being built at a capital cost of \$1.34 billion, which included a \$70 million agreement with Portos e Caminhos de Ferro de Mocambique, E. P., enabling Mozal to develop and operate a dedicated berth and other port terminal facilities at Matola, the port of Maputo. Feedstock for the smelter will be sourced from Billiton-owned alumina plants in Australia, Brazil, and Suriname. Modeled after Billiton's Hillside smelter at Richards Bay, South Africa, the project was designed to double the capacity of the smelter in the future. Detailed descriptions of the project, financing, and construction schedules are available at the company web site (URL <http://www.mozal.com>).

The Government and the U.S. Trade and Development Agency, in cooperation with the engineering firms, Asea Brown Boveri AG of Switzerland, Fluor Daniel Inc., and Kaiser Aluminum Corp. of the United States, signed a memorandum of understanding for a feasibility study on developing a second aluminum smelter in Beira. Funding and a timetable for the

study were not discussed (Pickard-Cambridge, December 15, 1998, Beira smelter project mooted, accessed January 30, 1999, at URL <http://www.bday.co.za/98/1215/news/n10.htm>).

Gold.—Such Canadian companies as Greenhope Resources Inc. and Trillion Resources Ltd. at the Muende, the Chifunde, the Chifumbazi, the Chicamba, the Chimeze, and the Zambuzi properties; the joint-venture partners Harambee Mining Corp. and Tan Range Exploration Corp. on the Chowalo and the Machinga gold concessions in the Archean greenstone belts of northwestern Mozambique; and Adamas Resources Corp. on the Niassa concession were actively exploring for gold during the year. Kenmare Resources Plc of Ireland also held a gold exploration license in the Niassa area. Other companies active in the country included Anglo American Corp., Gencor Ltd. and Lonrho Corp. of the United Kingdom, Ashanti Goldfields Co. Ltd. of Ghana, and Broken Hill Proprietary Ltd. (BHP) of Australia.

Iron and Steel.—JCI Ltd. and IDC were moving ahead with plans to develop a \$660 million, 2.5-million-metric-ton-per-year (Mt/yr) hot-briquetted iron (HBI) ore plant in the free trade zone near the port of Beira. Capital cost included \$190 million to build new port facilities. The plant would use 3.8 million metric tons (Mt) of iron ore fines from Brazil and low-cost gas from the Temane or the Buzi-Divinhe natural gas fields south of Beira. JCI also had an option to purchase iron ore from Iscor Ltd.'s of South Africa Sishen Mine. IDC was also examining the feasibility of building an adjacent \$300 million, 3.6-Mt/yr electric arc furnace steel plant to produce long steel products. JCI secured options, at less than \$0.75 per gigajoule, on the Temane gas with Atlantic Richfield Co. (ARCO) of the United States and Sasol Petroleum International (Pty.) Ltd. of South Africa and on the Buzi gas with the two Canadian companies holding the production-sharing agreement with ENH, Leopardus Resources Ltd. and Scimitar Hydrocarbons Corp. JCI held a 52% interest in the HBI project, the Mozambican Government, 20%; the Zimbabwean Government, 3%; and others, 25% (Reuters News, August 13, 1997, Mozambique iron plant vital for JCI future, accessed August 8, 1998, at URL http://www.leopardus.com/related_stories5.html; Mbendi Information Services, July 2, 1998, Mozambique—Direct iron reduction plant, accessed January 30, 1999, at URL <http://mbendi.co.za/indy/ming/mingmzfe.htm>). Feasibility studies for the project will also look at the potential impact of high carbon dioxide emissions from the proposed plant on nearby prawn fishing and air quality (Josey Ballenger, February 5, 1998, Iron project talks to be held in Beira, accessed February 9, 1998, at URL <http://bday.co.za/cgi-bin/post-query.perl>).

Following prolonged negotiations between the Mozambican Government and Enron Development Corp. of the United States, two agreements were signed. The first "Heads of Agreement" signed in September 1998 established the basis upon which the Government would approve and assist in the implementation of the gas-fueled Maputo Iron and Steel Project (MISP). The second, signed in March 1999, committed to develop the \$2.5 billion MISP. Capital costs would include the iron and steel project and the gas development. Under the

agreement, the MISP will use all of the gas from the Pande field in southern Mozambique and would include construction of a 610-km pipeline from the Pande gasfield to Maputo and a slurry pipeline to transport iron ore from 270 Mt of stockpiled byproduct titaniferous magnetite ore from the Palabora copper mine in South Africa to the Maputo plant. Railing the ore from the town of Phalaborwa was still an alternative. Enron and the IDC held 50-50 equity in the MISP, and Enron and ENH have the gas concession and will install the gas pipeline. The MISP was expected to produce approximately 3.5 Mt/yr of steel slabs for export from the Port of Maputo. Arrangements for project financing were pending approval by the Government. The project would take 42 months to build and generate about \$750 million in annual revenues. Mitsui Corp. of Japan and Duferco Steel Processing Ltd. of Switzerland were front runners to join as partners in the project (Alexander's Gas and Oil Connections, June 11, 1999, Enron to develop a gas, iron and steel project in Mozambique, accessed January 12, 2000, at URL <http://www.gasandoil.com/goc/company/cna92498.htm>).

Tantalum.—Harmony Gold Mining Co. of South Africa was developing a tantalum deposit at Morrua in Zambezia Province. Reserves were estimated to be 4.4 Mt containing 5.6% tantalum oxide. An open pit mine producing 450,000 t/yr of ore was planned (Mbendi Information Services, July 1, 1998, Mozambique—Mineral sands and rare earths mining, accessed August 12, 1998, at URL <http://mbendi.co.za/indy/ming/mingmzot.htm>).

Titanium.—In titanium developments, several projects were under investigation. Billiton conducted a \$3.9 million first-phase prefeasibility study in 1997 to examine the technical merits of developing the TiGen mineral sands project at Moebase, Zambezia Province, 500 km north of Beira. Billiton held a 100% interest in the project after acquiring the remaining minority equity interests of Edlow Resources Ltd. of Bermuda in 1996. According to Gencor (1997), exploration results indicated a resource in excess of 1 billion metric tons of sand containing some 4% heavy minerals. The contained titanium dioxide content was approximately 22 Mt. Ilmenite ore would be treated to produce 400,000 t/yr of titania slag at a plant at the port city of Nacala at a cost of \$500 million by 1999-2000. A source of power supply for the plant remained a problem. However, by yearend 1998, Billiton decided to delay proceeding to the final feasibility stage for 2 years pending an improvement in global market conditions and to reduce its country investment risk until the Mozal aluminum project was completed.

The joint venture between BHP International Minerals (Pty.) Ltd. (BHP) of Australia and Kenmare Resources PLC of Ireland was examining the feasibility of investing more than \$300 million to develop the Moma-Congolone titaniferous sands concession near Angoche/Quinga, Nampula Province. The Congolone project would produce 35,000 t/yr of zircon, 418,000 t/yr of ilmenite, and 8,000 t/yr of rutile by 2000. Under a July 1996 joint-venture agreement, BHP had the right to earn a 75% interest in the project by spending \$24.4 million on further exploration and development. However, in April 1999, BHP withdrew from the project, with full ownership reverting to Kenmare. Kenmare will seek other partners for the project.

During 1997, BHP performed more than 10,000 meters of drilling on the Moma-Congolone titanium project. This allowed them to increase the identified resource to more than 1 billion tons of mineralized sand containing about 35 Mt of ilmenite; or if the lower grade Quinga zone is included, 2 billion tons of sand containing more than 50 Mt of ilmenite. Work by BHP in 1998 established the Namalope resource of 13 Mt of ilmenite as an indicated resource; included the adjoining Tupuito and Tebani areas into BHP's resource category; prepared a mine plan demonstrating the minability of these three contiguous resource areas by low-cost dredge mining as a single mine containing more than 30 Mt of ilmenite; discovered a new high-grade zone at Pilivili containing large volumes of titanium minerals with a grade of around 8% ilmenite plus associated rutile and zircon (more than twice the average grade for the rest of the deposit); and conducted metallurgical testwork which demonstrated that the mine would generate products which fit within the specifications of the major consumers (Kenmare Resources Plc, 1999, Projects—Titanium (Moma-Congolone), accessed January 11, 2000, at URL <http://www.kenmareresources.com/congolone.html>).

Southern Mining Corporation of the Netherlands was exploring the Corridor Sands titanium project during 1998. The project is 200 km south of Maputo and 40 km inland. The company announced that by using a cutoff grade of 7% total heavy minerals, it had established a measured resource of 974 Mt at grades of more than 8.5% total heavy minerals. The total inferred resource was estimated to be 10 billion metric tons containing more than 500 Mt of heavy minerals, including smelter-feed-quality ilmenite, zircon, and rutile byproducts. An \$18 million feasibility study of the project by Bateman Minerals & Industrial Ltd. of South Africa of the project was initiated in October 1998 (Janet Parker, March 16, 1999, Southern gets a R117m injection, accessed December 30, 1999, at URL <http://www.bday.co.za/99/0316/company/c6.htm>).

The titanium project in the Limpopo River delta just north of Xai-Xai was being undertaken by Aquater S.p.A. of Italy, which spent \$3 million on exploration of the deltaic and inland extensions of the deposit in 1997 (African Mining, 1998).

Industrial Minerals

Cement.—Stimulated by major infrastructure development projects, production of cement has been on the rise, increasing to 290,000 t in 1998 and accounting for about 94% of domestic consumption. The country's sole producer, Cimentos de Moçambique, S.A.R.L., controlled by Cimentos de Portugal, SGPS, SA (Cimpor) of Portugal (51%) and by the Government (48%), had an annual capacity of around 300,000 metric tons (t) by 1998. In 1995, Cimentos de Moçambique had initiated a 10-year, \$100 million program to upgrade its plants at Matola, Dondo, and Nacala and to increase capacity to almost 900,000 t/yr of cement (International Cement Review, 1998).

Graphite.—Grafites de Ancuabe s.a.r.l (GDAS) was a joint venture among Kenmare Resources, the Government of Mozambique, and the United Kingdom's Commonwealth Development Corp. Kenmare increased its equity control of the company from 65% to 77% in 1997. GDAS was the world's leading producer of high-quality natural flake graphite. The

Ancuabe graphite mine is in northern Mozambique, 100 km inland from the port of Pemba. The ore body was in a slightly inclined graphite-bearing gneiss with an average grade of 10% graphite. A reserve of 1 Mt of ore grading 10% graphite was defined by diamond drilling for the feasibility study and additional very extensive, near-surface resources remain to be explored. Mining was by open pit method. Ore processing was by flotation and grinding to produce a standard 98% carbon graphite product. The processing plant had a nominal capacity of 10,000 t/yr of graphite product. During 1998, Kenmare was forced to run the operations at a higher level than designed for increase production to compensate for a 60% drop in graphite prices, leading to some mechanical failures that affected production and costs. A solution to plant power problems was developed in mid-1998 with the installation of larger alternators on which air filters to filter out conductive graphite dust were mounted. This improvement resulted in a satisfactory power supply. The Mozambican Government also responded by fast-tracking the extension of grid power to Ancuabe with connection expected in 2000. This allowed GDAS to conclude in 1998 a nonexclusive arrangement with Superior Graphite Co. of Chicago, one of GDAS' largest customers. This agreement allowed Superior to acquire 15% of the common stock of GDAS by investing approximately \$1.3 million (Kenmare Resources Plc, 1999, Projects—Ancuabe graphite mine, accessed January 11, 2000, at URL <http://www.kenmareresources.com/ancuabe.html>).

Other Minerals.—The Government-owned Companhia de Desenvolvimento Mineiro was actively pursuing exploration and development opportunities at the Boane bentonite deposit in Maputo Province, rare earths and tantalum prospects at Morrua with Grupo Madal s.a.r.l., and tantalum, kaolin, and rare-earth deposits in Muiane, Zambezia Province, with African Mining and Trust Pty. Ltd. of South Africa.

Fuels

Coal.—The Government gave a development priority to reopening the Moatize coal mine in Tete Province. The mines, which have been essentially inoperable for 10 years, were once the country's major export earner. Exploration by Companhia Vale do Rio Doce (CVRD) of Brazil and others in the 1980's and early 1990's identified coal resources of 15.8 billion tons in the Karroo sediments of the Province. Of the total proven coal reserves in the country of 2.28 Mt, 1.8 Mt of low-sulfur, high ash, bituminous coking coal reserves were located in the Moatize coalfield (Ruffini, 1998). In January 1997, the Government gave JCI an option to lead the development of Moatize. In March 1998, the South African coal companies, Ingwe Coal Corp. and Duiker Mining Ltd., took out options to join JCI and Austral Coal Ltd. of Australia to finance the \$750 million redevelopment of the Moatize Mine. The project would include a powerplant that would use steam coal produced as a secondary recovery product of the predominantly coking coal seam JCI was hoping to develop (David McKay, March 23, 1999, Two companies have options in JCI project, accessed January 30, 1999, at URL <http://www.bday.co.za/98/0323/e6.htm>). With no further public news, the project appeared to be on hold by yearend 1998. JCI planned to export the bulk of the

coal to Brazil on the return run of ore freighters bringing in CVRD iron ore for JCI's HBI plant at Beira.

Petroleum and Natural Gas.—The foreign investment interest in the petroleum and natural gas sectors was primarily for natural gas with three major gasfields, Buzi-Divinhe, Pande, and Temane, being considered for development. There were no known oilfields. Enron held an exclusive production-sharing agreement with ENH to invest at least \$1 billion to develop the estimated 70 billion cubic meters (2.5 trillion cubic feet) of reserves in the Pande gasfield and associated pipelines needed to feed other industrial projects (Africa Energy & Mining, 1999). The agreement was subject to Enron's ability to arrange project financing, which was also tied to proposed new iron and steel projects at Maputo. The September 1998 agreement for the MISP included the supply of natural gas from the Pande Field, which included the development of Pande Field in central Mozambique and the construction of a 610-km pipeline to transport natural gas from the Pande Field to the MISP in Maputo.

ARCO held the rights to natural gas reserves at the Temane field, south of Pande, along with two offshore blocks off the coast of Sofala Province. In May 1998, ARCO signed a production-sharing agreement with ENH for the Temane Gas Field, with an exploration commitment of \$10 million. The Temane Group partners were ARCO (47.62%), Sasol (47.62%), and Zarara Petroleum Resources Ltd. (4.76%). ARCO was negotiating a potential gas-marketing agreement with JCI Ltd. and Sasol, the latter for its Secunda synfuels plant in South Africa. A dedicated pipeline for the gas into South Africa would cost \$600 million. An aggressive drilling program by ARCO and Sasol on the Temane Field during 1998 increased estimates of gas reserves from 34 billion to 42 billion cubic meters (U.S. Embassy, Maputo, Mozambique, 1999).

The same partners signed similar production-sharing agreements on the Sofala and M 10 offshore blocks with ENH in May 1998 committing to spend \$30 million in exploration during 7 years. Scimitar Production International Ltd. of Canada and joint contractor Leopardus Resources of Canada, which have corporate ties to Zarara Petroleum Resources and Bin Ham Oil Group of the United Arab Emirates, held the rights from ENH to exploit the known gas resources of the Temane and the Buzi-Divinhe gas permit areas and to explore the Sofala and the M-10 offshore permit areas. Other companies actively exploring for natural gas and oil included BP Exploration Operating Co. Ltd. and Lonrho Petroleum Ltd. of the United Kingdom, Canop Worldwide Corp. of Canada, and Norbay Oil Corp. of the United States.

Infrastructure

Because the country's infrastructure suffered major damage and neglect during the prolonged war years, infrastructure development projects have been given a major priority. Spinoffs from the Mozal aluminum smelter project will include completion of high voltage transmission lines between the Cabora Bassa hydroelectric dam and South Africa; construction of the new \$1.5 billion, 2,500-megawatt Mepanda Uncua hydroelectric dam on the Zambezi River and an associated \$500 million, 1,500-km transmission line to Maputo; and renovation

of the Maputo Harbor to handle up to 10 Mt/yr of cargo, 800,000 t of which will be dedicated to Mozal aluminum project imports and exports. The joint Mozambique-South African Maputo Corridor Project between Johannesburg and Maputo will upgrade 500 km of road and rail links and dredge and improve Maputo Harbor to stimulate agricultural, industrial, and tourism development projects in both countries. The Maputo Corridor Project was expected to cost more than \$1 billion with 90% of financing coming from the private sector (Richard Meares, August 1, 1997, Reuters—Maputo Corridor boosted by smelters, ministers say, accessed August 1, 1997, at URL http://biz.yahoo.com/finance/97/08/01/gcor_y000_1.htm). To accommodate the HBI project, the port at Beira will be upgraded to handle 250,000-t ships with a 4-km-long pier. The 2,000-MW capacity of the Cabora Bassa dam and hydroelectric plant, which had been inoperable since 1982, was back in operation by 1998.

Outlook

With the development of the Mozal project well underway, the Mozambican economy appeared to be poised to undergo a major recovery based substantially on proposed new energy- and mineral-related investment and export-oriented industrial development. Although the outlook is optimistic, the full realization of the nearly \$12 billion in new investment is still contingent on several political and market factors. These include continued internal political stability and external regional cooperation, especially with neighbors, South Africa and Zimbabwe; continued positive market conditions for aluminum, coal, iron and steel, and titanium; and the ability of project management to attract the necessary development capital in competition with similar projects elsewhere in the world. The country's strong coal, gas, and hydroelectric energy base, however, remained a strong magnet for attracting the needed capital and industrial development.

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Major Sources of Information

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TABLE 1
 MOZAMBIQUE: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity 2/	1994	1995	1996	1997	1998 3/
Bauxite	9,620	10,700	11,459	8,218 r/	6,130
Cement, hydraulic e/ thousand tons	60	60	180	220	290
Clays, bentonite	3,350	3,500	11,051	12,625 r/	10,448
Coal, bituminous	58,190	40,000	40,000	100,000 e/	100,000 e/
Copper, concentrate:					
Gross weight	1,240	--	--	--	--
Cu content e/	259	--	--	--	--
Gemstones, semiprecious:					
Cut stones, all types carats	6,450	6,000	2,663	5,168 r/	5,303
Rough stones e/ 4/ kilograms	7,000	8,000	1,862	1,091 r/	1,465
Gold 5/ do.	6,804	6,800	67	6 r/	17
Graphite, concentrates	430	3,019	3,283	5,125	5,889
Marble:					
Block cubic meters	1,500	1,500	744	251	117
Slab square meters	52,300	52,300	18,232	13,820 r/	2,736
Salt, marine e/	40,000	40,000	60,000	60,000	60,000
Stone, sand and gravel					
Gravel, and crushed rock cubic meters	100,000 e/	100,000 e/	120,000 e/	123,532	282,832

e/ Estimated. r/ Revised.

1/ Data available through November 1999.

2/ In addition to the commodities listed, construction materials (other clays, sand and gravel, and stone) were produced, as was a small quantity of natural gas. For these commodities, output is not reported quantitatively, and information was insufficient to make reliable estimates.

3/ Reported data.

4/ Artisanal production of rough gemstones include, in order of importance, garnet, tourmaline, dumortierite, aquamarine, emerald, and Morganite.

5/ Does not include artisanal gold, for which there were no data, but for which the Government has estimated about 4,000 kilograms per year.

THE MINERAL INDUSTRY OF NAMIBIA

By George J. Coakley

Namibia is located on the southwest coast of Africa between South Africa and Angola. The 825,418-square-kilometer country had an estimated population of 1.65 million in 1998 and a gross domestic product (GDP) per capita of about \$4,100 based on purchasing power parity. In 1998, the mineral industry of Namibia provided about 43% of exports and 20% of the country's GDP. Diamonds remained the center of the mining industry in Namibia, followed by uranium, for which Namibia ranked as the world's fourth largest producer. Namibia was also the largest producer of salt in Africa. The minerals industry experienced significant setbacks with the long mining tradition at Tsumeb Corp. Ltd.'s copper and lead operations coming to an end with its sudden closure in early 1998 by its owner Gold Fields Ltd. of South Africa and an official liquidation in early 1999. The sole lithium producer NamLithium Mines (Pty.) Ltd. became insolvent and abandoned operations in June 1998. The owners of the Otjisondu Manganese Mines shut down suddenly owing to weak prices and loss of Asian markets. In early 1999, Shell Exploration and Production BV of the Netherlands and the South African power company Eskom withdrew from the proposed \$850 million development of the Kudu gasfield and powerplant. The Government's proactive policies, however, continued to encourage new entrants in copper, diamond, petroleum and natural gas, and zinc.

Namibia produced a range of metallic and industrial minerals. During 1998, production declines were seen in most metals with the exception of zinc owing to the closure of Tsumeb. (See table 1.) Production levels of most industrial minerals increased compared with those of 1997, with significant increases in fluorspar (+76%) and salt (+9%). The value of all mineral exports declined to \$626 million¹ in 1998 compared with \$727 million in 1997. Lower export revenues were partially offset internally by a 28% devaluation of the Namibian dollar, which was pegged to the South African rand. Of the \$626 million in mineral exports in 1998, diamonds accounted for 70%; the category of "uranium and others," 19.9%; zinc, 4%; gold, 3.2%; and copper-lead-silver, 2.5% (Murray, 1999).

Commodity Review

Metals

Copper-Lead-Zinc.—In a surprise move, Gold Fields closed down all mining and smelting operations in Namibia and laid off around 2,000 workers at the Tsumeb mine tailings retreatment area and at the Khusib Springs, the Kombat, and the

Otihiase Mines on April 16, 1998. The closure action was made with no advance notice to Gold Fields employees, triggering grievances and legal actions by the Mineworkers Union of Namibia and the Government of Namibia that took several months to resolve. The company was officially liquidated in March 1999. The Government continued with efforts to attract new investors to take over the Tsumeb operations.

In other copper developments, Namibia Copper Joint Venture (Pty.) Ltd., a partnership between Namibia Copper Mines Inc. (80%) of the United States and the Australian firm, Great Fitzroy Mines NL (20%), put its efforts to develop the Haib porphyry copper deposit in southern Namibia on hold pending improved copper market conditions and its evaluation of 1998 work done to reassess ore reserves. The company had previously reported the Haib deposit to have a minable resource of 604 million metric tons (Mt) of 0.341% copper. On the basis of a 1997 feasibility study, costs to develop the Haib open pit mine and associated solvent extraction/electrowinning facilities, with an annual output of more than 100,000 metric tons (t) of cathode copper, 530 kilograms of gold, and 880 t of molybdenum concentrate, were estimated to be \$560 million (Namibia Copper Joint Venture (Pty.) Ltd., 1998).

Imcor Tin (Pty.) Ltd., which operated the Rosh Pinah zinc-lead-silver mine, produced a zinc and a lead-silver concentrate. Contained zinc output increased by 4% to 42,142 t in 1998 compared with that of 1997. Contained lead increased 4% to 13,303 t with contained silver up 21% from 5 to 6 t. Following an agreement between Imcor's principal owners, Iscor Ltd. of South Africa and PE Minerals, a new 50-50 joint-venture operating company to be named Rosh Pinah Zinc Corp. will be established by mid-1999 and based in Windhoek; PE Minerals was a consortium of Namibian and Malaysian businessmen who held the mineral rights to the Rosh Pinah Mine. In a separate but related action during 1998, Iscor purchased the 65% interest not already owned by Iscor in the Zinc Corporation of South Africa Limited (Zincor) smelter from the shareholders, Gold Fields, New Wits Ltd., and Vogelstruisbult Metal Holdings Limited, for \$43 million. Rosh Pinah zinc concentrates were exported to the Zincor smelter in South Africa for refining, while the lead concentrate had been toll refined at Tsumeb, which had been closed. Exploration in 1997 had proven sufficient ore reserves to extend the life of the mine from 3 years to 12 years.

In a potentially major zinc sectoral development, Reunion Mining plc. of the United Kingdom completed exploration drilling and a feasibility study on the Skorpion zinc deposit, 20 kilometers (km) north of the Rosh Pinah Mine, in November 1998. Rights to the property were held by the Anglo American plc subsidiary Erongo Mining and Exploration Co. Ltd. By completing the favorable feasibility study, Reunion earned a

¹Where necessary, values have been converted from Namibian dollars to (N) to U.S. dollars at the rate of N5.9=US\$1.00 for 1998.

60% interest in the property. In turn, in April 1999, Anglo American bought Reunion Mining and took over 100% control of Skorpion. The purchase of Reunion coincided with Anglo's acquisition of the Black Mountain zinc mine and the Gamsberg zinc deposit in South Africa, giving Anglo added leverage in establishing a major zinc mining and smelting operation in the region. The feasibility study at Skorpion confirmed fully diluted proven reserves of 17.5 Mt grading 10.4% zinc and a further probable reserve of 2 Mt grading 7.6% zinc. Reserves would support a capital investment of \$280 million to mine 1.5 million metric tons per year (Mt/yr) of ore and to produce 150,000 metric tons per year (t/yr) of special high-grade refined zinc during the first 7 years, with a total mine life of 14 years (Murray, 1999).

Gold.—The Navachab gold mine accounted for more than 95% of total national gold production. The ore treatment plant at Navachab was upgraded during 1997 to increase throughput to 1.3 Mt/yr. The mine's parent company, AngloGold Ltd. of South Africa, was evaluating the feasibility of accessing ore below the current open pit design and extending the mine life by some 12 years. A decision was expected in March 1999.

Uranium.—Rossing Uranium Ltd., which was owned by Rio Tinto Plc of the United Kingdom, was the fourth largest producing uranium mine in the world, contributing about 9% of world supply in 1998. Faced with an extended weak market, it continued to operate at about 75% of capacity. Rossing played an important part in the Namibian economy, expending more than \$50 million per year in Namibia on wages, taxes, goods, and services and accounting for about 15% of mineral exports and about 10% of all other exports.

Industrial Minerals

Diamond.—Developments in 1998 may lead to an increase in diamond production from 1.4 million carats per year to about 2 million carats per year by yearend 1999. New investment in current operations by De Beers Marine (Pty.) Ltd. (Debmarmine) and Ocean Diamond Mining Holdings Ltd. (ODM) of South Africa and startup of new offshore diamond mining operations by the Canadian companies Namibian Minerals Corp. (Namco) and Diamond Fields International Ltd. (DFI) contributed to this increase. In November 1998, the National Assembly began drafting a new Diamond Law aimed at deregulating and decriminalizing the purchase, sale, and import/export of diamonds. The new law could end De Beers control over Namibian diamond marketing.

In 1998, production of diamonds increased by 4% to 1.47 million carats, slightly more than one-half from marine sources. Namdeb Diamond Corp. (Pty.) Ltd. (Namdeb), a joint venture of De Beers Consolidated Mines Ltd. of South Africa and the Namibian Government, accounted for 1.28 million carats of this output; about 61% came from onshore mining on its concession, which covers nearly 130 km of the coastal strip northwards of the Orange River. The 6% drop in Namdeb's production in 1998 was in response to weak demand and a 74% quota of normal diamond deliveries by De Beers Central Selling Organization. In 1998, Namdeb treated 26 Mt of beach sand materials and recovered 705,500 carats at a grade of 2.7 carats

per 100 t. Namdeb indicated that onshore reserves were more than sufficient for its current (1998) 10-year mine planning cycle but that production was set to be reduced progressively from 2003 when mining will shift to dump retreatment, dredging, and smaller operations (Murray, 1999).

Debmarmine, a subsidiary of the South African-based De Beers Consolidated, handled offshore marine mining for Namdeb and produced 497,128 carats of diamonds in 1998. Their concession extended from Oranjemund to Luderitz and up to 200 km into the Atlantic Ocean. Debmarmine operated six mining vessels off Namibia, including the newly commissioned *Gariiep*, which is equipped with a new crawler technology designed to mine low-grade sea bottom material. De Beers Consolidated's \$12 million diamond cutting and polishing plant at Okahandja became operational in early 1998.

Namco, a United Kingdom-based firm listed on the Toronto and Namibian stock exchanges, began commercial mining of diamonds in February 1998 on its offshore Koichab prospect in Luderitz Bay. In December 1997, Namco took delivery of NamSSol, a 120-t underwater mining crawler, which is operated from the mining vessel *MV Kovambo*. The NamSSol crawler, operating 20 hours per day during an expected life of 10 years, will deliver a slurry containing 18% solids to the processing plant on the *Kovambo*. The processing plant can treat 50 metric tons per hour with an expected recovery of 90% of the diamonds. The success of the crawler in 1998 led Namco to order a second, enhanced NamSSol II crawler that will be delivered by yearend 1999 and will permit an increase in production capacity to more than 300,000 carats per year. Namco produced 100,100 carats of diamonds, 95% of which were gem quality, for the year ending December 31, 1998. The average price was \$134 per carat received in fourth quarter 1998 sales. Stone size ranged from 0.1 to 10.3 carats with an average size of 0.33 carat. The company anticipates increasing output to 200,000 carats in 1999 (Namibian Minerals Corp., 1999).

ODM commissioned a new offshore mining and sampling vessel the \$7 million *Ivan Prinsep* in February 1999, contributing to an increase in diamond production to 63,074 carats for the year ending March 31, 1999. ODM's average diamond prices declined by 12 %, to an average of \$166 per carat, for a turnover of \$10 million. ODM's mining fleet also included the *MV Namibian Gem* and the *Oceandia* that are exploiting concessions covering an area around the 12 islands off the Namibian coast from Luderitz. A new real-time sonar visualization system on the *MV Namibian Gem* allowed ODM to increase productivity by recovering similar amounts of diamonds from areas 30% smaller than previous mining sites. The addition of the *Ivan Prinsep* should help ODM increase production to more than 100,000 carats per year within 2 years (Mining Journal, 1999).

Nora Exploration Inc. of Canada had interests in several offshore marine mining joint ventures. It held a 43% interest and an option to acquire the remaining 53% interest in Otjua Minerals (Pty.) Ltd. Otjua Minerals held the contract with Namdeb to develop its offshore Otjua concession, which had an inferred resource of 3.35 million carats. Nora generated about \$1 million in diamond sales during its financial year ending August 31, 1998, but operated at a loss and was reevaluating its sampling and mining methodologies. Nora held a 40% interest

in and an option to acquire up to 80% of a joint venture with Namibian Gemstones Mining Corp. (Pty.) Ltd. Namibian Gemstones had the rights to 23 deepwater concessions, representing the second largest marine diamond concession in southern Africa. Nora was evaluating the results of a major geophysical survey of 9,000-square-kilometer (km²) portion of the concession completed by the Council for Geosciences of South Africa during 1998. Nora was also negotiating joint ventures with Woduna Mining Holdings (Pty.) Ltd. on the 1,000-km² offshore Block J concession and with Karas Mineral Holding (Pty) Ltd. on its 900-km² offshore Block N (Nora Exploration Inc., 1998, Annual report for 1998, accessed November 30, 1999, at URL <http://www.nora.com/>).

DFI and its subsidiary Diamond Fields Namibia (Pty) Ltd. began exploration on its Luderitz offshore diamond mining concessions in 1998 and in October contracted Debmarine to conduct sampling and test mining by using Debmarine's mining vessel *MV Coral Sea*. DFI recovered 4,484 carats from its first-phase sampling program with an average size of 0.38 carat, which sold for an average value of \$164 per carat. The average sample grade was 1.28 carats per square meter.

Trans Hex International Ltd., the Canadian diamond exploration subsidiary of the South African parent company Trans Hex Group Ltd., continued exploration on Block 9 of its Northbank, Orange River property. The commencement of bulk sampling at the Northbank Project was delayed by the legal action of the surface rights owner, but the ruling of the arbitration commission cleared most of the impediments, and excavation of the first bulk sampling site was expected to begin in mid-1999. The Northbank property had a drill-indicated resource of 30 million cubic meters of gravel deposited in a 4-km by 900-meter paleochannel. Trans Hex continued parallel exploration for diamonds on its Skeleton Coast project with little success in 1998 (Trans Hex International Ltd., May 25, 1999, THI today announced the results of its operations for the fiscal year ending March 31, 1999, press release, accessed December 22, 1999, at URL <http://www.transhex.com/projects-fr.htm>).

Other companies active in diamond exploration during 1998 included the Australian companies Mount Burgess Gold Mining Co. NL and Kimberlite Resources Pty. Ltd. in the Tsumkwe region in northeast Namibia near the Botswana border and Kalahari Mining NL and Straits Resources Ltd. of Australia. The Russian diamond producer, Almazy Rossii-Sakha, signed an agreement to explore for diamonds near the Kalahari Desert on the Botswana border and for offshore marine deposits.

Fluorspar.—In 1997, Okorusu Fluorspar (Pty.) Ltd. was proceeding with its planned expansion to increase capacity to 80,000 t/yr of acid-grade fluorspar by 1999. Progress in 1998 was reflected by a 76% increase in production compared with that of 1997 to 40,683 t of fluorspar (Mark Dawe, Okorusu Fluorspar (Pty.) Ltd., oral commun., 1999)

Salts.—In 1998, production of industrial and refined sodium chloride salt increased by 9% to 536,480 t. Salt and Chemicals (Pty.) Ltd. was the primary producer, accounting for 434,200 t.

Mineral Fuels

In February 1998, the Government issued an Energy Policy White Paper that set a goal of meeting 75% of peak demand for electricity from domestic sources by 2010. Electricity consumption in 1998 was estimated to be 0.6 billion kilowatt hours. The two main projects designed to help to meet this goal were the Kudu natural gas project and the Epupu hydroelectric dam. Namibia was dependent on outside investment to meet this target.

The Kudu gasfield was held by Shell Exploration and Production Namibia B.V. (75%), Texaco Namibia Resources (15%), and Energy Africa Ltd. (10%). Estimates by Namibia's national electricity company NamPower indicated that this field contained reserves of 280 billion cubic meters of low-sulfur natural gas and could achieve gas flow rates in excess of 2.1 million cubic meters per day. Intensive seismic studies indicate the potential for up to 283 billion cubic meters, sufficient to power a 2,000-megawatt (MW) powerplant for more than a century (U.S. Embassy, Pretoria, South Africa, 1996). Other reports indicated that Shell and the Kudu Field's other operators felt that these reserve estimates may be too optimistic and that Kudu recoverable gas reserves were more on the order of 56 billion cubic meters. In May 1997, NamPower reached an agreement with Eskom to build a 750-MW combined cycle powerplant at Oranjemund that will use Kudu natural gas reserves. The Shell partnership was to finance the \$350 million development of the Kudu gasfield and share the \$500 million cost of building the powerplant with NamPower and Eskom (Mbendi Information Services (Pty.) Ltd., March 25, 1998, Namibia—Oil industry profile—Upstream, accessed September 22, 1998, at URL <http://mbendi.co.za/indy/oil/oilgnaus.stm>). The project had a major setback by early 1999 when Shell and Eskom withdrew their participation.

The proposed Epupa Dam project called for a 660-MW hydroelectric dam to be built on the Kunene River on the Angolan/Namibia border at a cost of \$540 million. Conflicts with Angola on the site of the dam, potential population dislocations, environmental impacts, and financing remained as problems.

Prior to opening up the Third Petroleum Licensing Round for bidding on open exploration acreage on October 1, 1998, the Government passed the Petroleum Law Amendments Act of 1998, which introduced a number of new incentives, including reduction of royalties on the value of oil and gas production from 12.5% to 5%, a reduction of the petroleum income tax from 42% to 35%, allowance for full annual writeoff for exploration and operating expenditures, and the introduction of three tiered "additional profits tax" that will become effective only when licensees earn an after-tax real rate of return of 15%, then 20%, and finally 25%.

Outlook

The rash of mine closures in 1998 have put a damper on the long tradition of mining in Namibia. A reopening of the traditional diamond regions in the south to exploration for other

mineral commodities and the renewed interest in offshore and mainland mineral exploration opportunities by foreign investors, however, has given hope for a new generation of mineral and energy projects in Namibia. Proposed new diamond, copper, and zinc mines and the potential for new value added manufacturing or metal-processing industries may keep the mineral sector a central part of the economy of Namibia for the foreseeable future. The Government's ability to attract new investment and to harness the natural gas and hydroelectric power potential of the Kunene River will strongly influence future economic growth. In the longer run, greater development of regional transportation infrastructure in northern Namibia, including the Caprivi Strip, could see Walvis Bay become a significant export route for new mineral developments in Angola and in the landlocked countries of Botswana and Zambia. With a climate that is among the driest in the world, Namibia will continue to deal with the lack of water resources as a constraint on development.

For more extensive coverage of the legislative framework, environmental issues and infrastructure of the minerals industry of Namibia, see the 1997 Minerals Yearbook, Volume III, Mineral Industries of Africa and the Middle East.

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Major Sources of Information

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Windhoek, Namibia
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 Fax: (264) 61 32809
 The Chamber of Mines of Namibia
 P.O. Box 2895
 Windhoek, Namibia
 Telephone: (264) 61 237-925/926
 Fax: (264) 61 222-638
 Geological Survey of Namibia
 Private Bag 2168
 1 Aviation Road
 Windhoek, Namibia
 Telephone: (264) 61 208-5111
 Fax: (264) 61 249-146
 Internet: <http://www.gsn.gov.na/survey.htm>
 Ministry of Mines and Energy
 Private Bag 13297
 1 Aviation Road
 Windhoek, Namibia
 Telephone: (264) 61 226-571 or 284-8111
 Fax: (264) 61 238-643
 Ministry of Trade and Industry
 Private Bag 13340
 Windhoek, Namibia
 Telephone: (264) 61 229-933
 Fax: (264) 61 220-227
 Government Internet site: <http://www.republicofnamibia.com>
 Namibia National Small Miners Association
 P.O. Box 7289
 Windhoek, Namibia
 Telephone: (264) 61 31088
 Fax: (264) 61 31188

Major Publications

Chamber of Mines of Namibia, Annual Report.
 Geological Survey of Namibia, 1992. The Mineral Resources of Namibia, 598 p.

TABLE 1
NAMIBIA: PRODUCTION OF MINERAL COMMODITIES 1/ 2/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997 3/	1998 3/
METALS					
Antimony, sodium antimonate (47% Sb):					
Gross weight	29	--	16	--	--
Sb content	14	--	8 e/	--	--
Arsenic, white, 99% arsenic trioxide	2,775	1,661	1,559	1,297 r/	175
Beryl concentrate	--	--	--	--	--
Cadmium metal, refined	19	15 e/	14	2	--
Cesium, pollucite, gross weight e/	5	--	--	--	--
Copper:					
Mine output, concentrate (28% to 30% Cu):					
Gross weight	97,900	81,646	57,095	66,879 r/	22,819
Cu content	28,400	22,530	14,845	17,879 r/	6,500
Metal, blister 4/	30,100	29,799	16,659	24,997 r/	8,014
Gold kilograms	2,445	2,394	2,145	2,417 r/	1,882
Lead:					
Mine output, concentrate (30% to 32% Pb):					
Gross weight	43,800	57,105	58,197	32,378	24,295
Pb content	13,917	16,084	15,349	13,577	13,303
Metal, refined, primary 4/	23,800	26,752	8,588	1,530 r/	236
Manganese, mine output, concentrate (44% Mn):					
Gross weight	--	95,385	92,647	39,671	--
Mn content	--	43,004	40,765	17,455	--
Silver, mine output, Ag content of concentrate kilograms	62,000	69,000	42,352	41,000 r/	23,000
Tin, mine output, concentrate (61% to 67% Sn):					
Gross weight	6 e/	--	--	--	--
Sn content	4 e/	2	--	--	--
Uranium, U ₃ O ₈ content of concentrate	2,235	2,366	3,188	3,775 r/	3,257
Zinc, mine output, concentrate (49% to 54% Zn):					
Gross weight	64,568	59,290	69,689	72,816 r/	78,670
Zn content	33,400	30,209	35,873	39,658 r/	42,142
INDUSTRIAL MINERALS					
Cement e/	20,000	20,000 r/	50,000 r/	100,000 r/	150,000
Diamond:					
Gem e/ thousand carats	1,312 3/	1,382 3/	1,402	1,345 e/	1,394 e/
Industrial e/ do.	--	--	--	71 e/	73 e/
Total do.	1,312	1,382	1,402	1,416	1,467
Fluorspar, acid grade (97% CaF ₂)	52,226	36,889	32,285	23,160 r/	40,683
Gypsum e/	121	--	--	--	2,596
Lithium minerals:					
Amblygonite	5 e/	3	46 r/	75	--
Lepidolite	90 e/	106	355	275	--
Petalite	650 e/	2,502	1,571	669	--
Total	745 e/	2,611	1,972 r/	1,019	500
Salt	356,965	303,986	355,868 r/	492,780	536,480
Semiprecious stones:					
Agate	175	115	150	175	161
Amethyst	338	5	19	23	--
Chrysocolla kilograms	6,500	--	--	--	900
Diopase do.	50 e/	--	--	--	--
Garnet	--	--	--	5	429
Quartz, crystal e/	50	--	15	--	--
Rose quartz	170	200	190	220	454
Sodalite	1,143	465	383	1,598	--
Tourmaline kilograms	600 e/	--	437 r/	53	--
Stone, sand and gravel:					
Dolomite	--	--	5,401	7,635	7,940
Granite	11,585	4,518	5,218	6,675	6,665
Marble	12,061	16,935	12,673 r/	13,743	9,020
Quartz e/	350	--	--	--	--

See footnotes at end of table.

TABLE 1--Continued
NAMIBIA: PRODUCTION OF MINERAL COMMODITIES 1/ 2/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997	1998
INDUSTRIAL MINERALS--Continued					
Sulfur, pyrite concentrate:					
Gross weight (49% to 51% S)	121,634	103,140	90,735	94,585	28,174
S content	60,000 e/	51,330	45,338	46,476	12,855
Wollastonite	1,309	967	248 r/	194	267

e/ Estimated. r/ Revised.

1/ Estimated data are rounded to three significant digits.

2/ Table includes data available through December 30, 1999.

3/ Reported figure.

4/ Includes products of imported concentrate.

TABLE 2
NAMIBIA: STRUCTURE OF THE MINERAL INDUSTRY IN 1999

(Metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
Cement		African Portland Cement	Otiwarongo, near Windhoek	150,000.
Copper		Tsumeb Corp. Ltd. (Gold Fields Namibia Ltd., 66%)	Khusib Springs Mine Tsumeb smelter	15,500 copper in concentrate, 60,000 blister copper.
Do.		do.	Kombat Mine, 50 kilometers south of Tsumeb	10,000 copper in concentrate.
Do.		Otihiase Mine (Tsumeb Corp. Ltd., 70% JCI/Ltd., 30%)	Otihiase Mine, near Tsumeb	18,000 copper in concentrate.
Diamond	thousand carats	Namdeb Diamond Corp. (Pty.) Ltd. (De Beers Centenary AG, 50%; Government, 50%)	Mines near Oranjemund; Elizabeth Bay Mine, 25 kilometers south of Luderitz; and marine operations	1,500.
Do.	do.	Namibian Minerals Corp. (NAMCO)	Marine operations offshore Luderitz and Hottentots Bay	200 (300+ by 2000).
Do.	do.	Ocean Diamond Mining Holdings Ltd. (NAMCO, 50.8%)	Marine operations offshore Luderitz	80 (100 by 2000).
Do.	do.	Trans Hex International Ltd.	Northbank, Orange River	
Do.	do.	Diamond Fields Namibia (Pty.) Ltd.	Marine operations offshore Luderitz	5 (sampling stage).
Do.	do.	Nora Exploration Inc.	Otiua offshore concession	8 (sampling stage).
Fluorspar		Okorusu Fluorspar (Pty.) Ltd. (Solvay Group, 100%)	Okorusu, 48 kilometers north of Otiwarongo	50,000, 98% calcium fluoride; 80,000 by 1999.
Gold		Erongo Mining and Exploration Co. Ltd. (Anglo American Corp., 67.5%, Inmet Mining Corp., 20%, Randgold Ltd., 10%)	Navachab Mine near Karibib	3.
Lead		Tsumeb Corp. Ltd. (Gold Fields Namibia Pty. Ltd., 66%)	Tsumeb (Ausmelt) smelter (closed in 1998)	24,000 lead bullion.
Do.		Rosh Pinah Zinc Corp. (Iskor Ltd., 50%; PE Minerals, 50%). Formerly Imcor Tin (Pty.) Ltd.	Rosh Pinah Mine, 80 kilometers northeast of Oranjemund	15,000 lead in concentrate.
Lithium		NamLithium Mines (Pty.) Ltd. (Kloekner; Matramco)	30 kilometers south of Karibib (closed in June 1998)	1,500 concentrate.
Manganese		Otijsosondo Manganese Mines Ltd. (Cranford Namibia Pty. Ltd., 100%)	Otijsosodu, 160 kilometers north- east of Windhoek (closed in 1998)	100,000 ore with 45% manga- nese content.
Salt		Salt and Chemicals (Pty.) Ltd. (Sentrachem, 100% ?)	Walvis Bay brine pans	450,000.
Do.		Salt Company (Pty.) Ltd. (private, 100%)	Swakopmund	150,000.
Stone	cubic meters	Karibib Mining and Construction Co. (Namibia) Ltd. (private, 100%)	Marble quarry at Karibib Granite quarry	2,500, 600.
Uranium		Rossing Uranium Ltd. [Rio Tinto plc, 68.6%; Cogema (France), 10%]	Rossing, 30 kilometers east of Swakopmund	5,000 uranium oxide.
Zinc		Rosh Pinah Zinc Corp. (Iskor Ltd., 50%; PE Minerals, 50%)	Rosh Pinah Mine, 80 kilometers northeast of Oranjemund	45,000 zinc in concentrate.

THE MINERAL INDUSTRY OF

NIGER

By Philip M. Mobbs

Niger was an internationally important uranium producer, annually exporting concentrate containing approximately 3,900 metric tons of yellow cake (U_3O_8). The country had a significant area of the West African Birimian greenstone belt under exploration for gold. According to the Ministry of Mines, Niger also had indications of barite, chromite, columbium-tantalum, copper, graphite, iron ore, lead, lithium, monazite, molybdenum, nickel, phosphates, platinum-group metals, silver, talc, titanium, and zinc occurrences (Ministère des Mines, de l'Industrie et de la Technologie, 1997). The output of mining accounted for about 4% of the gross domestic product.

The state owns title to all mineral rights. Law 93-016 and Decree No. 93-044/PM/MMEI/A provide the legal framework for the mining industry. The Government retains 10% free equity in mining ventures with the option to purchase an additional 23% equity in mineral-production ventures. There is a 5.5% royalty on the commercial value of exported minerals.

A set of sixteen 1:100,000 geologic maps of the Liptako region of western Niger was released in 1998. The mapping was funded by the Fonds d'Aide et de Coopération of France. Three greenstone gold belts in the Liptako region were the focus of the gold exploration in Niger, and the Government estimated that production of artisanal gold from the region was about 1 metric ton per year; however, for many junior mining companies, 1998 was a difficult year to raise funds for gold exploration, and the Nigerian gold rush faltered.

Anmercosa Exploration (Niger) Ltd., a subsidiary of Anglo American Corp. of South Africa, acquired 65% interest in a joint venture with Coronation International Mining Corp. of the United Kingdom on the Namaro gold concession. Anmercosa also acquired a 50% interest in Barrick Gold Corp.'s Tialkam gold property. Ashanti Exploration Ltd., a subsidiary of Ashanti Goldfields Co. Ltd. of Ghana, began the year as the operating partner for three joint ventures. Ashanti's joint venture on the Tera gold property with Carlin Resources Corp. of Canada floundered when financial problems forced Carlin to cease all exploration and to reorganize in early 1998. In September, Ashanti withdrew from the joint venture on the Nassile concession of Royalstar Resources Ltd. of Canada. Royalstar wrote off the property's expenses and was considering disposal options. North of the Nassile concession, Ashanti and IAMGOLD Corp. of Canada continued exploration of the Saoura concession.

African GeoMin Mining Development Corp. of the Cayman Islands, a subsidiary of Etruscan Resources Inc. of Canada (formerly Etruscan Enterprises Ltd.), began a feasibility study of the Samira gold deposit on the Tiawa concession. Placer Dome Inc. of Canada had withdrawn from an option agreement on Samira with Etruscan, and discussions concerning a joint venture on the property with Anmercosa began in 1998. Etruscan and the Office National des Ressources Minières were

exploring the Koma Bangou prospect. Etruscan and the Berlant General Trading Establishment of Kuwait were exploring the Kossa gold permit. BF Geomin Mining Development Corp. of Canada, affiliated with Etruscan, acquired the Datambi gold permit. Auspex Minerals Ltd. of Canada wound down exploration of the Koulbaga gold concession. Ressources Robex Inc. of Canada acquired 10% interest in the Tafassasset project, a four-concession gold project, from GeoAfrica Gold Corp. of Canada., a subsidiary of the European Pacific Group of Australia.

Funding problems forced Cornucopia Resources Ltd. of Canada to terminate exploration of the Tera gold concession. EXP Resources Ltd. of Canada was unable to secure financing for its exploration program on the Tin-Awati gold-copper concession of Proma Minerals SA of Norway. Sumitomo Corp. of Japan and Imperial Metals Corp. of Canada were negotiating to farm out their interest in the M'Banga gold concession.

Uranium concentrates were produced by the Société des Mines de l'Air (SOMAÏR) and Compagnie Minière d'Akouta (COMINAK) of Niger. Uranium remained the main mineral export of Niger and accounted for about 70% of Niger's foreign exchange earnings (Mining Journal, 1998). SOMAÏR's open pit operations were located northwest of Arlit, approximately 250 kilometers (km) northwest of Agadez. COMINAK's underground operations were located near Akouta, approximately 10 km southwest of the SOMAÏR pits.

Production of industrial minerals and mineral fuels was limited to a few commodities that were consumed domestically. Scancem International AB of Norway acquired 77% equity interest in the Malbaza Cement Works of Société Nigérienne de Cimenterie from the Government.

Esso Exploration and Production Niger Inc., a subsidiary of Exxon Corp. of the United States, and its partner, Elf Aquitaine Group of France, drilled three exploration wells on the Agadem concession in southeastern Niger. TG World Energy Inc. of Canada, an affiliate of Trego International Inc., was looking for partners to finance drilling on its oil prospecting license in the Ténéré region adjacent to the Esso-Elf permit.

The mineral industry of landlocked Niger depended on road and rail transportation to access the ocean. Highways linked Niamey, the capital of Niger, with ports at Accra, Ghana; Abidjan, Côte d'Ivoire; Cotonou, Benin; Lagos, Nigeria; and Lomé, Togo; and to railroad terminals at Ouagadougou, Burkina Faso (approximately 500 km by highway from Niamey), and Parakou, Benin (approximately 560 km by highway from Niamey).

Mineral industry operations did not appear to be physically affected by the military mutinies of 1998; however, the turmoil coupled with increased political risk and declining mineral commodity prices did not make fund raising any easier for exploration companies. Uranium will probably remain the most

important mineral commodity produced in Niger and the largest foreign exchange earner for the immediate future. Development of additional natural resources, such as gold, iron ore, petroleum, and phosphates, has the potential to provide additional jobs and foreign exchange revenue for the country.

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Major Sources of Information

Ministère des Mines, de l'Industrie et de la Technologie
B.P. 11700
Niamey, Niger

Telephone: (227) 73-45-82
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Office National des Ressources Minières
B.P. 12716
Niamey, Niger
Telephone: (227) 73-59-25
Fax: (227) 73-28-12

Major Publications

- Bureau of Geological Consultancy, 1993, Golden opportunities in Liptako: Brussels, Bureau of Geological Consultancy, 30 p.
Mining Journal, 1993, Niger Country Supplement: London, Mining Journal, v. 321, no. 8234, July 23, 12 p.
Ministry of Mines and Energy, 1998, Mining Investment Opportunities: Ministry of Mines and Energy, Niamey, Niger, 42 p.

TABLE 1
NIGER: ESTIMATED PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity 2/	1994	1995	1996	1997	1998
Cement, hydraulic	29,200	30,000	29,251 r/ 3/	30,000	30,000
Coal, bituminous	133,500	135,000	140,000	140,000	145,000
Gold	1	1	1	1	1
Gypsum	1,700	1,800	1,800	1,800	2,000
Salt thousand metric tons	3	3	3	3	3
Tin, mine output, Sn content	20	20	10	10	10
Uranium, U content	2,975 3/	2,970 3/	3,320 3/	3,497 r/ 3/	3,731 3/

r/ Revised.

1/ Includes data available through July 1999.

2/ In addition to the commodities listed, phosphate, tungsten, and a variety of construction materials (clays, limestone, sand and gravel, and stone) were produced; but information was inadequate to make reliable estimates of output.

3/ Reported figure.

THE MINERAL INDUSTRY OF

NIGERIA

By Philip M. Mobbs

Nigeria, Africa's most populous nation, was the continent's largest oil producer in 1998. According to the U.S. Department of Energy, Nigeria ranked 11th in production of crude petroleum and condensate by volume, accounting for about 3% of world production and about 7% of the Organization of Petroleum Exporting Countries' (OPEC) total production (Energy Information Administration, June 1999, International petroleum statistics report, accessed July 16, 1999, at URL <http://www.eia.doe.gov/emeu/ipsr/t11.html>). With exports of 251 million barrels of oil to the United States, Nigeria was America's fifth largest supplier of crude petroleum (U.S. Energy Information Administration, June 1999, Table 21—Imports of crude oil and petroleum products into the United States by country, Petroleum Supply Annual 1998, v. 1, accessed July 16, 1999, at URL http://www.eia.doe.gov/oil_gas/petroleum/data_publications/pet_data_publications.html).

The oil sector was the cornerstone of the Nigerian economy, providing about 80% of total Government revenues and accounting for about 96% of the country's total export earnings (Tola Akinmutimi, Guardian, July 21, 1999, Nigeria's exports drop, reflects economic downturn, accessed July 21, 1999, at URL <http://www.nwguardiannews.com/business/bn755603.htm>; Bassey Udo, March 12, 1999, Post Express, [untitled], accessed March 16, 1999, at URL <http://postexpresswired.com/postexpress.nsf/cae9a9be809d4d8a85256436005cf58e/c17c4d4f2383651f852567320000c205?OpenDocument>). Petroleum accounted for more than 40% of the country's gross domestic product (GDP) compared to agriculture's contribution of 30% (Hawkins, 1999; Bassey Udo, Post Express, [untitled], March 12, 1999, accessed March 16, 1999, at URL <http://postexpresswired.com/postexpress.nsf/cae9a9be809d4d8a85256436005cf58e/c17c4d4f2383651f852567320000c205?OpenDocument>). Other primary mineral production accounted for less than 0.3% of GDP (Tradeport, March 3, 1998, Metals conference, accessed July 14, 1999, at URL <http://tradeport.org/ts/countries/nigeria/mrr/mark0017.html>).

Despite recurrent disruptions in the availability of petroleum fuels and electrical energy, Nigeria's GDP was reported to have grown by an estimated 2.3% in 1998 compared with a 3.8% growth rate in 1997 (Hawkins, 1999).

Government Policies and Programs

The transitional military Government, installed in June 1998, introduced widespread reforms of Nigeria's mineral industry. The new Government abolished the Ministry of Petroleum Resources, however, many of its functions were assumed by the Department of Petroleum Resources (Bassey Udo, Post Express, August 31, 1998, Scrapping of Petroleum Ministry elicits mixed reactions, accessed September 1, 1998, at URL <http://postexpresswired.com/postexpress.nsf/cae9a9be809d4d8a85256436005cf58e/93ab6149f4d7ba2685256671005869d7?OpenDocument>).

A national policy on solid minerals, approved by the Federal Executive Council in April, was confirmed by the Provisional Ruling Council at yearend. In December, the Government also promulgated new mineral laws and regulations (Isa Abdulsalami, December 23, 1998, Government approves solid minerals policy, deregulates coal production, Guardian, accessed January 22, 1999, at URL <http://www.ngrguardiannews.com/news/nn7340608.htm>).

The Ministry of Solid Minerals Development was involved in the promotion, exploration, and development of Nigeria's solid minerals. (See table 1.) The Department of Petroleum Resources concerned itself with the oil and natural gas segment of the mineral industry. The Ministry of Mines, Power, and Steel administered the iron and steel sector. Environmental regulations were administered by the Federal Environmental Protection Agency and the Department of Petroleum Resources.

All mineral rights were held by the Federal Government, which continued to encourage strongly the diversification of the nation's mineral industry. Only licensed activities were authorized to conduct mining operations; however, decades of Government indifference to the nonfuel mineral industry have resulted in widespread unregulated artisanal mineral operations (Ikenna Nwosu, October 20, 1998, Investment in Nigerian solid minerals sector, Post Express, accessed November 4, 1998, at URL <http://postexpresswired.com/postexpress.nsf/cae9a9be809d4d8a85256436005cf58e/0c8a3b7d43206160852566ac00595008?OpenDocument>).

Profits earned on production of most minerals were subject to a 30% tax rate. Petroleum company profits were subject to an 85% tax. The tax on profits from natural gas production was reduced to 35% in January 1998 (Yahoo, January 6, 1998, Nigeria cuts income tax for gas projects, accessed January 7, 1998, at URL http://biz.yahoo.com/finance/980106/nigeria_gas_1.html). Gas royalty payments were 7% for onshore production and 5% for offshore production. Onshore oil production was subject to a 20% royalty. Offshore oil production royalty rates ranged from 16.67% for operations in water depths of less than 200 meters (m) to 0% for production from water depths in excess of 1,001 m.

Petroleum and water issues resulted in border disputes. Cameroon and Nigeria had taken the ownership of the oil-prospective Bakassi Peninsula to the International Court of Justice. Equatorial Guinea and Nigeria disputed the location of the national boundary in the vicinity of offshore oil development. Niger and Nigeria were negotiating the issue of a decade-old dam on the Zango River in Niger and the resultant desiccated Lake Kalmalo in Nigeria (Oghoghor Obayuwana, Guardian, May 6, 1999, Nigeria, Equitorea [sic] Guinea opt for peaceful resolution of border dispute, accessed May 6, 1999, at URL <http://www.ngrguardiannews.com/news/nn748020.htm>; Abubakar Umar, October 8, 1998, Nigeria, Niger disagree on Lake Kalmalo, Post Express, accessed October 8, 1998, at URL

<http://postexpresswired.com/postexpress.nsf/7c45df0e9873ec4885256436005d3eb0/affe1cc7c16a7dbc85256696007ef782?OpenDocument>).

The Government's effort to reduce natural gas flaring was augmented by the January 1998 increase in the cost of flaring from \$0.006¹ per 28.3 cubic meters (m³) (1,000 standard cubic feet) to \$0.12 per 28.3 m³ (Hussain, 1998). The lack of natural gas demand when the oilfields were established resulted in little associated gas gathering infrastructure. The oil companies flared an estimated 18.6 billion cubic meters per year of gas (Bassey Udo, August 25, 1998, 45.8 billion kilowatts of heat generated daily in Niger Delta, Post Express, accessed August 25, 1998, at URL <http://postexpresswired.com/postexpress.nsf/cae9a9be809d4d8a85256436005cf58e/7422028512f7f2848525666a00742ffd?OpenDocument>).

The retail fuel shortage continued during 1998. The fuel importers of the old regime, Glencore International AG of Switzerland and Wintershall AG of Germany, were superseded when the new Government authorized African Petroleum Plc; Elf Petroleum Nigeria Ltd., a subsidiary of Elf Aquitaine Group of France; Mobil Oil Nigeria Plc; Shell Petroleum Development Co. Ltd.; Texaco Nigeria Plc; and Unipetrol Nigeria Plc to import refined petroleum products (Africa Energy & Mining, 1999). The shiploads of incoming products overloaded the petroleum handling capacity of the ports (Chijama Ogbu, March 19, 1999, Nigeria lacks capacity to cope with fuel imports, says workshop, Post Express, accessed March 19, 1999, at URL <http://postexpresswired.com/postexpress.nsf/cae9a9be809d4d8a85256436005cf58e/f3a8755d9a839dcd85256738006963c3?OpenDocument>).

The Government deregulated the liquefied petroleum gas market in October and abolished the petroleum distribution monopoly of the Pipelines and Products Marketing Co. Ltd. (PPMC), a subsidiary of the Nigerian National Petroleum Corp. (NNPC), in December. Also in October, the Government proposed to retain 40% of Calabar Cement Co. Ltd., Jos Steel Rolling Co. Ltd., Katsina Steel Rolling Co. Ltd., National Electric Power Authority (NEPA), NNPC, Oshogbo Steel Rolling Co. Ltd., and the steel plants. Forty percent of each enterprise was to be sold to international investors, and 20%, to local investors (Joseph Latunji, October 19, 1998, Privatization of manufactures, accessed June 30, 1999, at URL <http://tradeport.org/ts/countries/nigeria/mrr/mark0009.html>).

The Oil Mineral Producing Areas Development Commission (OMPADEC) had been formed in 1992 as the Government's vehicle for funneling oil revenues back to the oil-producing communities. OMPADEC had, in theory, received 3% of the national oil revenue. In 1998, the new Government increased the OMPADEC share of oil revenue to 13%.

At yearend, the Government established a special tribunal to adjudicate oil spill compensation, replacing the regular courts.

Trade

Spot prices for Bonny Light, Nigeria's crude oil export standard, averaged \$12.77 per barrel in 1998 compared with \$19.40 per barrel in 1997 and \$21.24 per barrel in 1996 (Middle East Economic Survey, May 19, 1999, Spot quotations for the

¹Where necessary, values have been converted from naira (₦) to U.S. dollars at the average exchange rate of ₦85.5=US\$1.00 in 1998.

OPEC reference basket, accessed July 7, 1999, at URL http://www.mees.com/dotcom/opec_basket). The value of all Nigerian exports in 1998 was \$9.7 billion, down from \$15.2 billion in 1997. Oil exports were valued at \$9.3 billion in 1998 compared with \$14.9 billion in 1997 (Hawkins, 1999; Holman, 1999).

Barite, bentonite, gypsum, and kaolin imports were officially prohibited; however, local production of barite and gypsum often did not meet quality specifications of the end-users, and imported material was often used.

Commodity Review

Metals

Aluminum.—Startup of the \$2.5 billion smelter of Aluminium Smelter Co. of Nigeria Ltd. (ALSCON) continued to be restrained by funding, gas pricing and supply, and transportation problems. One potline had been energized in 1997. By the end of 1998, the 193,000-metric-ton-per-year (t/yr) capacity smelter was producing at the rate of only 100 metric tons per day. Funding of the 70% state-owned joint venture was constrained by the Government's budget problems. ALSCON continued to negotiate during the year for lower natural gas prices with Shell. ALSCON was seeking natural gas at about \$0.77 per 28.3 m³. Shell was offering to supply gas at \$1.53 per 28.3 m³ of natural gas. Prices charged to industrial consumers for natural gas by Nigeria Gas Co. (NGC) ranged from \$1.58 to \$1.94 per 28.3 m³, but NGC reportedly supplied gas to the state-owned NEPA at about \$0.04 per 28.3 m³ (Bassey Udo, October 19, 1998, FG may review prices of gas, Post Express, accessed October 19, 1998, at URL <http://postexpresswired.com/postexpress.nsf/cae9a9be809d4d8a85256436005cf58e/bcefa9ff6f9130af852566a3000e1ffa?OpenDocument>).

A dredging contract for deepening the Imo River to 14 m was abrogated by the Government in 1998 owing to lack of progress (Post Express, March 9, 1999, Dredging of Imo River resumes at instance of ALSCON, accessed March 9, 1999, at URL <http://postexpresswired.com/postexpress.nsf/cae9a9be809d4d8a85256436005cf58e/2838be0e565bf4dd8525672e004cf113?OpenDocument>). The shallow Imo River channel forced ALSCON to use barges to transship raw materials in and finished products out from the smelter at Ikot Abasi. Many of the plant's 1,800 workers went on strike in October, demanding that junior staff salaries be adjusted upward after the new Government increased the national minimum wage. Strikers also demanded that \$650 be paid to each nonexpatriate worker as a production bonus for keeping the plant in operation for a year (Post Express, October 29, 1998, Strike forces Alscn production down by 10 per cent, accessed October 29, 1998, at URL <http://postexpresswired.com/postexpress.nsf/cae9a9be809d4d8a85256436005cf58e/7dfe38bf0b8a8703852566ac0047cc9e?OpenDocument>). Repair costs for equipment damaged during the 1-week strike were estimated to be \$100 million (Mining Journal, 1998).

Steel.—The Government authorized funds to resume steelmaking at Delta Steel Co., which had ceased production in 1995. After production resumed, the Government announced that Delta Steel was to be leased to Chinese investors, and Delta

1995. After production resumed, the Government announced that Delta Steel was to be leased to Chinese investors, and Delta Steel announced that it required an additional \$18.2 million to renovate the plant, \$15.6 million to satisfy its debt to NEPA, and \$6 million to pay accrued retirement benefits and staff wages (Post Express, September 11, 1998, Chinese investors to take over Delta Steel, accessed September 11, 1998, at URL <http://postexpresswired.com/postexpress.nsf/7c45df0e9873ec4885256436005d3eb0/8e9cb1de0bd90b188525667b0065a5e1?OpenDocument>).

Former Government ministers and relatives of the former president had bought Ajaokuta Steel Co. Ltd.'s \$2.5 billion debt to Russian contractors for \$500 million. The new Nigerian Government undertook an investigation to determine if the \$2 billion windfall was an attempt to defraud the nation; the contractors and the Russian Government viewed the deeply discounted factoring transaction as a valid means of removing the decade-old debt from the contractor's books (Chris Onuorah, December 21, 1998, Russia may not probe Ajaokuta Steel fraud, Post Express, accessed on February 1, 1999, at URL <http://postexpresswired.com/postexpress.nsf/7c45df0e9873ec4885256436005d3eb0/7be1402678612f9b852566e20001da3a?OpenDocument>).

Industrial Minerals

Cement.—The eight Nigerian cement plants were not able to satisfy local demand. Plants were battered by the fuel shortages that adversely affected plant operations and product delivery. The Government proposed to assist with the rehabilitation of inefficient plants and suggested a new cement plant be erected in Guyuk in Adamawa State (Post Express, July 7, 1998, FG sets up task force on Cement Technology Institute, accessed July 13, 1998, at URL <http://postexpresswired.com/postexpress.nsf/cae9a9be809d4d8a85256436005cf58e/532036998a64472e8525663900466717?OpenDocument>).

Scancem International A.S. of Norway acquired 40% of the shares in Bonny Allied Industries Ltd., a new 25,000-metric-ton-storage-capacity cement import terminal in Port Harcourt. Scancem sold its holdings in the Eastern Bulk Cement Ltd. terminal in Port Harcourt.

Clay.—Kaolin demand was estimated to be 170,000 t/yr. Two kaolin processing plants were commissioned in 1998, the Kankara Kaolin and Chemical Industries near the Kankara Mine in Katsina State and the Crystal Kaolin Factory near the Major Porter Mine in Plateau State. Nigeria Kaolin Ltd. proposed to expand its production to 50,000 t/yr. Other kaolin operations were in Akwa-Ibom, Ekiti, Imo, and Rivers States.

Gemstones.—Nigeria has the potential for becoming a significant gemstone supplier to the world market. There was artisanal recovery of amethyst, aquamarine, beryl, emerald, sapphire, topaz, tourmaline, and zircon. In July, the Igbojaye and Ofiki areas in southwest Nigeria were overrun by Malian and Senegalese nationals illegally mining the community's gemstone deposits.

Glass.—Guinea Glass Plc rebuilt a 38,000-t/yr-capacity glass furnace in Agbara, Ogun State.

Nitrogen.—The effective fertilizer price increase for consumers after the 1997 removal of the federal fertilizer subsidy depressed demand in 1998 and output from the National Fertilizer Co. (NAFCON) plant was marginally reduced by a 2-week strike that ended in August (Iheanyi Amuta, August 19, 1998, Workers' strike costs NAFCON N10.5 billion, Post Express, accessed August 19, 1998, at URL <http://postexpresswired.com/postexpress.nsf/7c45df0e9873ec4885256436005d3eb0/0340bf5af63545b385256664005b5686?OpenDocument>). Sales were expected to rebound and NAFCON was planning a plant expansion adjacent to its original site in Onne, Rivers State. The lead contractor for the NAFCON II expansion was M.W. Kellogg Co. of the United States.

Salt.—Salt was produced from brine by small-scale solar and wood-fired evaporation operations in Plateau State. Local salt production augmented imported salt produced by Brazilian subsidiaries of the Nigerian companies, the Dangote Group and Union Dicon Salt Plc. The Ministry of Solid Minerals proposed development of a rock salt deposit in Kaseyo, Benue State.

Mineral Fuels

Bitumen.—With the Nigerian Bitumen Project, the Government was promoting the development of the surface petroleum seepages and the tar sands of southwestern Nigeria as a source of bitumen for the local road construction and repair market, which in 1998 was wholly dependent upon imported bitumen. Bitumen runs at the Kaduna refinery had ended by mid-1997 when the refinery was closed for rehabilitation. A lease sale for 15 bitumen exploration and development blocks was proposed for 1999.

Coal.—Associated with the new mining laws and policies, the Government deregulated the Nigerian coal industry in 1998, abolishing the monopoly that the underfunded Nigerian Coal Corp. had on coal exploration and production (Isa Abdulsalami, December 23, 1998, Govt approves solid minerals policy, deregulates coal production, Guardian, accessed January 22, 1999, at URL <http://www.ngrguardiannews.com/news/n734608.htm>). Coal output included production from the Enugu underground mine in Enugu State and the open pits of the Okaba Mine in Kogi State and the Owukpa Mine in Benue State. The 36,000-t/yr Okpara Mine in Enugu State underwent an equipment upgrade in 1998. Transportation conditions constrained production, especially the coal storage capacity of the terminal at Port Harcourt (Turner, 1999). There were additional coal deposits at Afikpo in Ebonyi State; Amansiodu, Ezimo, Inyi, and Ogugu in Enugu State; Dekina and Ogboyoga in Kogi State; and Lafialobi in Nassarawa State. Lignite deposits occurred in Abia, Arambra, Delta, and Imo States.

Natural Gas.—The \$865 million Oso Condensate Project of Mobil Producing Nigeria Utd. (51%) and NNPC (49%) shipped its first liquids, about 30,000 metric tons (t) of propane and butane, in 1998 (Goddy Ikeh, September 8, 1998, Mobil exports natural gas liquids to United States, Pan African News Agency, accessed September 11, 1998, at URL <http://www.africanews.org/PANA/economics/19980908/feat3.html>).

The 5.78-million-metric-ton-per-year (Mt/yr)-capacity² Nigeria Liquefied Natural Gas Ltd. (NLNG) facility was scheduled to come on-stream in 1999. The NLNG consortium, NNPC (49%), Shell (25.6%), Elf (15%), and Nigerian Agip Oil Co. (10.4%), authorized the construction of a third 2.9 Mt/yr production line to come on stream in 2002 (Turkish Daily News, May 29, 1998, Nigerian LNG firm to expand \$3.7 bln plant, accessed May 29, 1998, at URL http://www.turkishdailynews.com/tdn/freedaily_tdn/latest/econ2.htm). The expansion of the plant at Finima on Bonny Island was estimated to cost an additional \$1.2 billion (Oil & Gas Journal, 1999). Companies were completing gas wells and installing the gas-gathering infrastructure and compression equipment needed to convey natural gas to NLNG.

During 1998, Shell joined the West African Gas Pipeline consortium of Chevron Nigeria Ltd., Ghana National Petroleum Corp., NGC, Société Beninoise de Gaz S.A., and Société Togolais de Gaz S.A. The consortium initiated a \$2 million feasibility study in August for the proposed 5-million-cubic-meter-per-day pipeline. The 1,000-kilometer (km) pipeline was expected to cost about \$400 million (Hussain, 1998).

A 20,000-barrel-per-day natural gas-to-liquids plant was proposed by Chevron Overseas Petroleum Inc. and Sasol Ltd. of South Africa. The \$700 million synthetic crude oil plant was to be built adjacent to Chevron Nigeria Ltd.'s Escravos gas plant in Delta State (Kingsley Kubeyinje, May 29, 1998, Work begins on gas plant, Business Day, accessed June 11, 1998, at URL <http://www.bday.co.za/98/0529/world/w34.htm>).

Shell Nigeria Gas Ltd. (SNG) was formed in March 1998 to focus on the downstream gas market. SNG committed \$39 million to build 40-km and 70-km gas transmission pipelines from NGC facilities to industrial customers (Post Express, July 20, 1998, Shell Nigeria Gas announces new launch date, accessed July 21, 1998, at URL <http://postexpresswired.com/postexpress.nsf/7c45df0e9873ec4885256436005d3eb0/ffea7f085689a5f385256647005a76d8?OpenDocument>; Bassey Udo, July 24, 1998, Eight firms conclude plans to source gas from Shell, Post Express, accessed July 24, 1998, at URL <http://postexpresswired.com/postexpress.nsf/7c45df0e9873ec4885256436005d3eb0/e331a56cc19e4fa08525664a00508cd1?OpenDocument>).

Petroleum.—Six joint ventures with NNPC produced most of the oil in Nigeria, with nearly half of the oil produced by the joint venture operated by Shell Petroleum Development. (See Table 2). Fields controlled by six indigenous companies accounted for about 4% of total production. Since 1993, a number of international oil companies and 48 indigenous oil firms have entered into production-sharing contracts with the Government, which shifted the burden of funding exploration to the oil companies.

Frequent production breaks in 1998 were attributed to accidents or social unrest. The Shell joint venture alone was subject to 325 incidents compared with 150 in 1997 (Shell Nigeria Petroleum Development Co. Ltd., 1999, Security in Nigeria, accessed July 9, 1999, at URL http://www.shellnigeria.com/shell/security_rhs.asp). Production from the Delta region was reduced during community protests through much of

August and again in October (Corzine, 1998; Petroleum Economist, 1998b; Associated Press, December 1, 1998, Shell closes part of pipeline, accessed December 4, 1998, at URL http://dailynews.yahoo.com/headlines/ap/international/story.html?s=v/ap/19981201/wl/nigeria_oil_1.html).

For 1998, the NNPC's joint-venture partners proposed exploration and production projects that would require more than \$5 million in federal funding for the NNPC; however, the Government's 1998 budget allocated only \$2.5 billion to NNPC. During 1998, the Government's income was adversely affected by the decreasing international oil prices, OPEC's reduction of Nigeria's oil production quota, and reduced petroleum production owing to often-violent civil disturbances in the Delta producing region (BBC News, January 1, 1999, Oil prices threaten Nigerian economy, accessed January 5, 1999, at URL http://news.bbc.co.uk/hi/english/world/africa/newsid_246000/246301.stm). Because of the reduced income, the Government was unable to satisfy budgeted funding demands, and funds that were released did not become available until August 1998 (Shell Petroleum Development Co. Ltd., 1999, 1998 in perspective, accessed on July 9, 1999, at URL http://www.shellnigeria.com/info/env_1998/1998t.html; Matthew Tostevin, May 12, 1998, [untitled], Reuters, accessed May 12, 1998, at URL http://biz.yahoo.com/finance/980512/oil_nigeri_1.html). Delayed funding and the drop in oil prices forced a number of the joint ventures to defer proposed operations, caused staff layoffs, and reduced funding for community projects (Mfon Ekefre Uyo, July 8, 1998, Mobil to increase production level, Post Express, accessed July 13, 1998, at URL <http://postexpresswired.com/postexpress.nsf/7c45df0e9873ec4885256436005d3eb0/0ff084d580ff81a48525663a005ef103?OpenDocument>; Yahoo, May 4, 1998, Mobil says cut Nigeria jobs to match budget, accessed May 5, 1999, at URL <http://biz.yahoo.com/rf/990504/beg.html>). The limitations of multinational business companies apparently have not been perceived by the communities. Many clans were upset and felt that the oil companies were targeting their natives for layoff or retirement and that the reduced community development efforts were directed at them (Mfon Ekefre, June 13, 1999, Akwa Ibom indigenes demand N20b compensation from oil firms, Post Express, accessed on June 29, 1999, at URL <http://postexpresswired.com/postexpress.nsf/7c45df0e9873ec4885256436005d3eb0/bec3cc90652d5b71852567920055532d?OpenDocument>; Jude Okwe, June 19, 1998, Eket youths plan protest rally against Mobil, Post Express, accessed June 23, 1998, at URL <http://postexpresswired.com/postexpress.nsf/7c45df0e9873ec4885256436005d3eb0/2a45acc5085b45d48525662b004dc278?OpenDocument>).

Oil companies indicated that 90% to 95% of their local employees were Nigerian; however, many communities loudly complained about the oil companies' unfair treatment, including that companies failed to give their clanspersons contract and employment preference over other Nigerians, that not one of their indigenes was on the board of directors or a manager of a company operating in their community, and that of the Nigerians sent out of the country for training, not one was a native of their community (Iheanyi Amuta, November 11, 1998, Egi youths urge Elf Petroleum to abide by agreement, Post Express, accessed November 19, 1998, at URL <http://postexpresswired.com/postexpress.nsf/7c45df0e9873ec4885256436005d3eb0/64f2c28d807e886a852566c1000f0f2b?OpenDocument>).

²Upon regasification at the discharge terminals, the proposed annual plant output will be equivalent to 7.15 billion cubic meters of natural gas.

nt; Michael Faloseyi, September 10, 1998, Tension in oil communities blamed on connivance between Govt, oil firms, Post Express, accessed September 19, 1998, at URL <http://postexpresswired.com/postexpress.nsf/7c45df0e9873ec4885256436005d3eb0/8cae56df74ae6f088525667a007eda72?OpenDocument>; Post Express, September 17, 1998, Cause of oil firms, indigenes rift identified, accessed September 17, 1998, at URL <http://postexpresswired.com/postexpress.nsf/7c45df0e9873ec4885256436005d3eb0/3acf921fba0493eb8525668100555345?OpenDocument>).

In 1996, the Government had decreed that all marginal oilfields were to be relinquished to the Ministry of Petroleum Resources. It estimated that there were 183 marginal oilfields, primarily small, undeveloped oil prospects, within the holdings of the joint venture that could be leased to indigenous oil companies. The multinational oil companies countered that the prospects had not progressed beyond exploration drilling because of the Government's failure to fund NNPC's share of development costs compounded by the OPEC production quota. Additionally, the oil companies considered the 1996 decree to be a breach of contract of the original oil mining concession terms (OPEC Bulletin, 1998; Post Express, March 19, 1998, Marginal oil fields' crisis—Oil firms point the way forward, accessed April 1, 1998, at URL <http://postexpresswired.com/postexpress.nsf/cae9a9be809d4d8a85256436005cf58e/85864b5b751b99e3852565cc0057d5d3?OpenDocument>). Chevron did farm out the undeveloped Ogbelle and Omerelu Fields to Jerez Energy International Inc. of Canada and Niger Delta Petroleum Resources of Nigeria in late 1997; however, throughout 1998, the companies awaited official Government approval of the transaction. Chevron had discovered the Ogbelle Field in 1981 and drilled the discovery well on the Omerelu prospect in 1987. Chevron also farmed out the Ajape Field to African Petroleum Plc, Star Oil Fields, and Nigerian Petroleum Development Co.

Early in 1998, Liberty Technical Services Ltd., a wholly owned subsidiary of Abacan Resources Corp. of Canada, drilled the Ima #9 well. The well tested a different, deeper sand package than the rest of the Ima Field. At midyear, Liberty's partner, Amni International Petroleum Development Co. Ltd. of Nigeria, terminated the joint venture on oil mining lease (OML) 112 and oil prospecting lease (OPL) 237 and became sole owner of the petroleum production from Ima Field's shallow reservoirs. Liberty retained a 10% working interest in the deep Ima sand package (Abacan Resources Corp., 1998).

Ashland Oil Nigeria Ltd. divested its Nigerian operations, including 50% interest in OML 90, 114, 118, and 225, to a subsidiary of Addax Oryx Group Ltd. of Switzerland. Ashland had been producing about 17,000 barrels per day (bbl/d) prior to the Government's revoking its production-sharing license in June 1997 when Ashland attempted to sell its interest to Perenco Investments S.A. of France without official Government approval (Petroleum Economist, 1998a).

The joint venture of Atlas Petroleum International Ltd. of Nigeria; CXY Nigeria Oil Field Services Ltd., a subsidiary of Canadian Occidental Petroleum Ltd.; and Summit Oil and Gas Worldwide Ltd., a subsidiary of TransAtlantic Petroleum Corp. of Canada (formerly Profco Resources Ltd.), began production from the five-well Ejulebe Field on Block OML 109, in 14 m of water about 15 km offshore. Production was piped to Conoco Energy Nigeria Ltd.'s 1.7-million-barrel-storage-capacity floating production and storage offtake tanker on the Ukpokiti

Field (Journal of Petroleum Technology, 1998).

The Chevron Nigeria Ltd. joint venture began production from the Dibi, Ewan, Gbokoda, and Opolo Fields in 1998. Gbokoda was the joint venture's first oilfield in the Delta region to be developed without flaring associated natural gas. Produced gas was piped to Escravos. The Opolo Field, in 43 m of water, was developed by horizontal drilling. In October, some of the Chevron/NNPC joint-venture production facilities were occupied by people protesting the Government's policies and lack of investment in local infrastructure. Production of about 100,000 bbl/d was suspended during the occupation (Doggett, 1998). A Chevron Petroleum Nigeria Ltd. joint venture drilled three deepwater wells, two of which discovered oil.

The Government selected Elf to be the operator for the development of the Amenam-Kpona prospect, which straddled Elf's OML 99 and Mobil Producing Nigeria Ultd.'s OML 70 leases. Production was expected to begin in 2000. The Elf/NNPC joint venture brought the Ofon Field on-line in 1998. The Elf (40%), Chevron (30%), and Exxon (30%) venture drilled the Ukot-1 discovery well on OPL 222, about 97 km offshore in 750 m of water.

Mobil suffered a 40,000-barrel oil slick from a pipeline moving crude oil from the Idoho offshore facility to the Qua Iboe terminal. The January 12 spill originated about 20 km offshore and washed ashore on January 19. The ruptured pipeline was shut down and production of about 100,000 bbl/d of crude oil was suspended until repairs had been completed at the end of February (Yahoo, February 27, 1998, Nigeria Mobil says oil output back to normal, accessed March 2, 1998, at URL http://biz.yahoo.com/finance/980227/oil_nigeri_2.html). The local communities subsequently contended that Mobil failed to comply completely with the original compensation request of \$720,000 and increased the compensation demand to \$12 million. In December, community youth attacked Shell's Forcados terminal because Mobil's offshore facilities were inconvenient (Reuters, May 4, 1999, Mobil says spent over \$52 mln on Nigerian spill, accessed May 5, 1999, at URL <http://biz.yahoo.com/rf/990504/be2.html>).

In 1998, Shell brought the Ogbotobo and the Agbaya Fields on-stream and continued its pipeline upgrade program, awarding a \$32 million contract for coating more than 2,500 km of its oil pipelines (Bassey Udo, September 18, 1998, Shell awards N2.7 billion contract, Post Express, accessed September 21, 1998, at URL <http://www.postexpresswired.com/postexpress.nsf/cae9a9be809d4d8a85256436005cf58e/2cb068fbc0e2b8dd8525668200593eb3?OpenDocument>). Shell initiated the \$65 million Odidi associated gas gathering project, to recover 108,000 cubic meters per day of gas which was being flared. Global Energy and Refining Ltd. of the United States began a \$150 million project to strip natural gas liquids from gas supplied by Shell's Bonny Division fields. Shell would sell the resultant dry gas. Shell announced a \$500 million rehabilitation and expansion of the Bonny crude oil export terminal (Joseph Ollor-Obari, December 11, 1998, N43 billion expansion for Bonny oil terminal, Guardian, accessed January 22, 1999, at URL <http://www.ngrguardiannews.com/business/bn733401.htm>).

Star Deep Water Petroleum Ltd., a subsidiary of Texaco Inc. of the United States, and Famfa Oil Ltd. of Nigeria drilled the Agbami-1 wildcat on OPL 216 in 1,433 m of water. The joint

venture of Star Deep Water, the Statoil Group, and BP Amoco Plc (formerly British Petroleum Plc) began drilling the Nnwa-1 on OPL 218 in 1,282 m of water at yearend.

The Niger delta region reportedly lacked much of the infrastructure commonly found on drier ground (Iheanyi Amuta, August 19, 1998, Angry old men, women lock out Agip workers, Post Express, accessed August 19, 1998 at URL <http://postexpresswired.com/postexpress.nsf/7c45df0e9873ec4885256436005d3eb0/4206785e9b0d20f385256664005b065f?OpenDocument>). The dearth of retail petroleum products outlets in the Delta has resulted in the illegal cottage industry of selling gasoline by the jerrycan. Fuel was typically obtained by gathering puddled fuel from spills. Accelerated corrosion of pipelines in the swamp environment result in spills, but a majority of the 72 spills reported in 1998 were attributed to sabotage by exasperated youths or communities (Post Express, July 14, 1999, NNPC boss links oil spillage to vandalism, accessed July 29, 1999, at URL <http://www.postexpresswired.com/postexpress.nsf/7c45df0e9873ec4885256436005d3eb0/7536a0ff302e7ffe852567af005a7b84?OpenDocument>). Additionally, fuel may be obtained from petroleum product pipelines punctured for the occasion or by siphoning off refined products from the pipelines (Chijama Ogbu, November 27, 1998, Petroleum sector—Ways out of the mire, Post Express, accessed November 30, 1998, at URL <http://postexpresswired.com/postexpress.nsf/cae9a9be809d4d8a85256436005cf58e/44ed961363994c51852566c80058bfb?OpenDocument>; Kenneth Ugbechie, October 22, 1998, ...Youths still siphon fuel from burst pipe, Post Express, accessed October 22, 1998, at URL <http://www.postexpresswired.com/postexpress.nsf/7c45df0e9873ec4885256436005d3eb0/e2063966519c1bf6852566a50002dfac?OpenDocument>).

An estimated 2,068 people were killed in Jesse (population 12,000), near Warri, in Delta State by an explosion and fire on October 17. The people were engaged in gathering fuel leaking from a PPMC pipeline pumping gasoline from the Warri refinery to the storage and distribution facilities at the Kaduna refinery when the fuel caught fire (Iheanyi Amuta and Adagogo Brown, February 10, 1999, Jesse fire—Death toll now 2,068, Post Express, accessed February 10, 1999, at URL <http://postexpresswired.com/postexpress.nsf/7c45df0e9873ec4885256436005d3eb0/b745bf4f42423f7f85256714001cc4c4?OpenDocument>; BBC News, October 29, 1998, Nigeria inferno death toll climbs, accessed November 2, 1998, at URL http://news.bbc.co.uk/hi/english/world/africa/newsid_203000/203765.stm).

Because of the fire and pipeline damage, PPMC cut off the fuel supply to northern Nigeria. Petroleum products were moved north by truck until the damage was repaired. There was a respite in pipeline vandalism after the fire, but by October 23, PPMC reported another incident of pipeline sabotage (Post Express, October 25, 1998, Another oil pipe vandalized, accessed October 27, 1998, at URL <http://postexpresswired.com/postexpress.nsf/7c45df0e9873ec4885256436005d3eb0/7d45f6a967536469852566a9004b8f50?OpenDocument>).

In March, Total S.A. of France was awarded the \$214 million contract to repair the closed 110,000-bbl/d Kaduna crude oil refinery. Commercial production was scheduled to resume in January 1999. The New Port Harcourt refinery and the Warri refinery operated intermittently. Equipment often failed, and incidents of pipeline sabotage frequently cut off oil supply.

Infrastructure

NEPA originated more than 99% of the electricity generated in Nigeria. Its five thermal plants and three hydroelectric facilities had an installed electricity generating capacity of 5,876 megawatts (MW), but most plants were in poor condition, and NEPA was unable to meet local demand of about 2,480 MW (Aronze Okafo, June 1, 1997, Electric power generation, accessed July 14, 1999, at URL <http://tradeport.org/ts/countries/nigeria/mrr/mark0033.html>; Bassey Udo, August 20, 1998, NEPA still bedeviled with problems...despite FG assurances, Post Express, accessed August 20, 1998, at URL <http://www.postexpresswired.com/postexpress.nsf/cae9a9be809d4d8a85256436005cf58e/d5a4d89fd54782cc85256665004b03ae?OpenDocument>). The underfunded state-owned company suffered from high debt, vandalism, and lack of maintenance and spare parts (Chijama Ogbu, March 3, 1999, NEPA seeks to increase capacity to 131 percent, Post Express, accessed March 3, 1999, at URL <http://postexpresswired.com/postexpress.nsf/cae9a9be809d4d8a85256436005cf58e/96ee0e1cee254e82852567280055fae?OpenDocument>). The local business response to the lack of electricity supply was to buy small generators; however, the fuel crisis that began in 1997 and extended through 1998 hindered the effectiveness of that option (Wallis, 1999).

The China Civil Engineering Construction Corp. had completed nearly 80% of the rehabilitation of the Nigerian railroad by yearend. About 1% of the nation's freight had been moved by rail prior to the reconstruction of the system (Timeyin Uwejamomere, March 15, 1999, Lower Niger project to tackle 16 million cu.m dredge spoils, Guardian, accessed March 16, 1999, at URL <http://www.ngrguardiannews.com/property/pn742803.htm>). In 1998, Nigeria Railway Corp. increased the volume of freight hauled to 1.5 million metric tons compared with 137,000 t in 1996. In addition to rail, signal, and trackbed work, the Chinese delivered 35 locomotives, 320 freight cars, and 118 passenger cars (Josiah Emerole, February 12, 1999, N104b needed to complete rehabilitation of rail tracks, Post Express, accessed February 25, 1999, at URL <http://postexpresswired.com/postexpress.nsf/7c45df0e9873ec4885256436005d3eb0/2776406b905efd8f852567160005baf?OpenDocument>; Post Express, February 26, 1999, Slow pace of railway development blamed on political crisis, accessed on March 3, 1999, at URL <http://postexpresswired.com/postexpress.nsf/7c45df0e9873ec4885256436005d3eb0/9a790954b9d0b63a85256723007827a5?OpenDocument>). An indication that the company was viewed as being viable came in October when a campaigning politician requested that the Nigerian Railway follow the example of the foreign oil companies and provide bridges, employment, hospitals, roads, and scholarships for the communities the rail line passed through (Kalu Okoronkwo, October 25, 1998, Railway, coal corporations urge to emulate oil firms, Post Express, accessed October 27, 1998, at URL <http://postexpresswired.com/postexpress.nsf/7c45df0e9873ec4885256436005d3eb0/b36ec3b0bb43868d852566a9004c9452?OpenDocument>).

In response to an oil production regulation change requiring that oil facilities have at least 30% local content, Nigerdocks Nigeria Plc opened a \$16 million shipyard designed for the offshore construction market (OPEC Bulletin, 1998; Walter Ukaegbu, October 4, 1998, New shipyard for commissioning

tomorrow, Post Express, accessed October 6, 1998, at URL <http://postexpresswired.com/postexpress.nsf/7c45df0e9873ec4885256436005d3eb0/d028f28df892ef6f85256694007b7836?OpenDocument>).

Outlook

The cost of doing business in Nigeria has been increasing. Attacks on oil facilities are becoming a preferred method to gain a forum to direct the Government's attention to the needs of the population. Many of the 1,500 villages in the Delta region look to the multinational companies to provide physical and social infrastructure, such as bridges, electricity, retail fuel outlets, hospitals, jetties, roads, scholarships, schools, telephone connections, and potable water lines (Iheanyi Amuta and Adagogo Brown, February 10, 1999, Jesse fire—Death toll now 2,068, Post Express, accessed February 10, 1999, at URL <http://postexpresswired.com/postexpress.nsf/7c45df0e9873ec4885256436005d3eb0/b745bf4f42423f7f85256714001cc4c4?OpenDocument>). International oil companies have community assistance programs in place that addressed some of the needs and traditionally have felt that it was the Federal, the local, or the State government's responsibility to provide infrastructure; however, the new Government began urging companies to do even more community development (Iheanyi Amuta, July 1, 1998, Bayelsa administrator imposes curfew in Brass LGA, Post Express, accessed July 13, 1998, at URL <http://postexpresswired.com/postexpress.nsf/7c45df0e9873ec4885256436005d3eb0/b5756eb304f6c3278525663300696ee5?OpenDocument>).

The nation's dependence on oil has been highlighted by the economic problems associated with the continued fuel shortage. Development of nonfuel minerals would significantly broaden the country's industrial base. The Government's fiscal and financial incentive programs are designed to attract local and foreign investments in the mineral industry; however, the country's reputation for civil strife, corruption, fraud, political uncertainty, and poor infrastructure has apparently tempered international investor's interest (Ayittey, 1998; Finance Africa, 1997; Metal Bulletin, 1997; Rupert, 1998; Soji Akin, 1998, Nigeria business information—A "policeman" for the Nigerian economy, accessed June 11, 1998, at URL <http://www.afbis.com/nigeria/neic.htm>; Kingsley Kubeyinje, May 11, 1998, Nigeria establishes zones to boost the country's exports, Business Day, accessed May 12, 1998, at URL <http://www.bday.co.za/98/0511/world/w17.htm>; United Nations Development Programme, March 27, 1992, Fourth country programme for Nigeria, accessed July 1, 1998, at URL <http://www.undp.org/undp/rba/country/cp/3087j.htm>).

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 ———1998b, Nigeria: Petroleum Economist, v. 65, no. 12, p. 43.
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 Wallis, William, 1999, Teething troubles abound as Nigeria tries to wean itself off state ownership of industry: Financial Times [London], March 30, p. 5.

Major Sources of Information

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Other Publications

- Nigeria Ministry of Solid Minerals Development, 1996, Solid minerals development in Nigeria: Abuja, Nigeria, Ministry of Solid Minerals Development, 34 p.
 ———1997, Brief on Nigeria's mining potentials: Abuja, Nigeria, Ministry of Solid Minerals Development, 17 p.
 ———1998, Mineral occurrences in Nigeria: Abuja, Nigeria, Ministry of Solid Minerals, CD-ROM.

TABLE 1
NIGERIA : PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity 2/ METALS	1994	1995	1996	1997	1998 e/
Aluminum	--	--	--	2,500 e/	20,000
Columbium and tantalum concentrates: e/					
Gross weight	30	65 3/	57 3/	60 3/	70
Columbium content	17	26	23	23	30
Gold e/ grams	4,800 3/	5,000	6,000	6,000	10,000
Iron and steel: e/					
Iron ore, gross weight thousand tons	400	168	100	50	--
Steel, crude do.	105 3/	36	-- r/	--	2
Lead, metal, refined e/ do.	4	4	4	4	5
Tin:					
Mine output, cassiterite concentrate:					
Gross weight	278 e/	357	139	150	200
Sn content e/	185 3/	250	100	100	130
Metal, smelter	179	259	100	100	100
INDUSTRIAL MINERALS					
Barite 4/	--	--	--	4,000 e/	5,000
Cement, hydraulic e/ thousand tons	2,600 3/	2,602 r/	2,545 r/	2,520 r/	2,700
Clays:					
Kaolin	105,000	11,950	102,078	100,000	110,000
Unspecified e/	104,000	100,000	100,000	100,000	100,000
Feldspar	1,000 e/	3,722	800	1,000	500
Gypsum e/	10,000	150,000 3/	383,250	300,000	300,000
Nitrogen: e/					
N content of ammonia thousand tons	200	170	164	134	167
N content of urea do.	200	100	114	41	105
Stone:					
Limestone do.	2,700	3,128	2,095	2,000	2,000
Marble do.	8	67	29	30	30
Shale e/ do.	32 3/	500	500	500	500
Topaz e/ kilograms	1,022 3/ 5	1,000 e/	1,500	1,500	1,700
MINERAL FUELS AND RELATED MATERIALS					
Coal, bituminous	130,000 e/	29,000	7,116	7,000	30,000
Gas, natural: e/					
Gross million cubic meters	34,000	35,000	37,000	30,000 r/	24,000
Dry do.	4,600	5,000	6,000	3,000 r/	3,000
Petroleum:					
Crude thousand 42-gallon barrels	743,500	740,000	798,620	845,000 r/	788,000
Refinery products:					
Gasoline do.	23,000	24,900	23,000 e/	13,000 e/	11,000
Jet fuel e/ do.	500	350	300	200	200
Kerosene do.	12,000	14,200	10,000 e/	8,000 e/	6,000
Distillate fuel oil do.	22,000	23,000	20,000 e/	10,000 e/	9,000
Residual fuel oil do.	20,000	23,000	18,000 e/	12,000 e/	12,000
Unspecified do.	13,500	21,200	8,000 e/	7,000 e/	6,800
Total do.	91,000	106,650 r/	79,300 e/	50,200 e/	45,000

e/ Estimated. r/ Revised.

1/ Includes data available through July 23, 1999.

2/ In addition to the commodities listed, amethyst, aquamarine, barite, bitumen, diamond, emerald, garnet, granite, gypsum, lead, phosphate rock, sapphire, soda ash, talc, tourmaline, zinc, zircon, and a variety of crude construction materials (stone, sand and gravel) are produced, but information is inadequate to estimate output.

3/ Reported figure.

4/ Considerably more barite is produced but is considered to be commercially unusable.

5/ Exports.

TABLE 2
NIGERIA: STRUCTURE OF THE MINERAL INDUSTRY IN 1998

(Thousand metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
Aluminum		Aluminum Smelter Co. of Nigeria (Government, 70%; Ferrostaal AG of Germany, 20%; and Reynolds International of the United States, 10%)	Ikot Abasi	97 1/
Cement		West Africa Portland Cement Co. (Associated International Cement, 39.4%; Odu'a, 26.8%; public, 17.2%; Government, 16.6%)	Ewekoro Shagamu	750 600
Coal		Nigerian Coal Corp. (Government, 100%)	Enugu	150
Iron and steel:				
Iron ore		National Iron Ore Mining Co. (Government, 100%)	Itakpe	5,500
Iron		Delta Steel Co. Ltd. (Government, 100%)	Aladja	2,000
Steel		Ajaokuta Steel Co. Ltd. (Government, 100%)	Ajaokuta	1,350 2/
Do.		Delta Steel Co. Ltd. (Government, 100%)	Aladja	1,000
Steel products		do.	do.	300
Do.		Jos Steel Rolling Co. Ltd. (Government, 100%)	Jos	210 3/
Do.		Katsina Steel Rolling Co. Ltd. (Government, 100%)	Katsina	210
Do.		Oshogbo Steel Rolling Co. Ltd. (Government, 100%)	Oshogbo	210 3/
Natural gas, liquefied		Nigeria Liquefied Natural Gas Ltd. (Nigerian National Petroleum Corp., 49%; Royal Dutch/Shell Group, 25.6%; Elf Nigeria Ltd., 15%; and Nigeria AGIP Oil Co. Ltd., 10.4%)	Finima, Bonny Island	5,780 2/
Nitrogen				
Ammonia, nitrogen content		National Fertilizer Co. of Nigeria Ltd. (Ministry of Finance, 63%; Nigerian National Petroleum Corp., 30%)	Onne	300
Urea, nitrogen content		do.	do.	255
Petroleum:				
Crude	million 42-gallon barrels	Joint venture of Shell National Petroleum Corp. (operator), 30%; Agip Energy & Production Nigeria Ltd., 5%; Elf Petroleum Nigeria Ltd., 10%; and Nigerian National Petroleum Corp., 55%	Niger Delta	365
Do.	do.	Joint venture of Mobil Producing Nigeria Unlimited (operator), 40% and Nigerian National Petroleum Corp., 60%	do.	200
Do.	do.	Joint venture of Chevron Nigeria Ltd. (operator), 40% and Nigerian National Petroleum Corp., 60%	do.	150
Do.	do.	Joint venture of Nigerian Agip Oil Co. Ltd. (operator), 20%, Phillips Oil Co. (Nigeria) Ltd., 20%, and Nigerian National Petroleum Corp., 60%	do.	70
Do.	do.	Joint venture of Elf Petroleum Nigeria Ltd. (operator), 40%; and Nigerian National Petroleum Corp., 60%	do.	50
Do.	do.	Joint venture of Texaco Overseas Nigeria Petroleum Co. Unlimited (operator), 20%; Chevron Oil Co. Nigeria Ltd., 20%; and Nigerian National Petroleum Corp., 60%	do.	25
Do.	do.	Joint venture of Express Petroleum and Gas Co. Ltd., (operator), Camac International (Nigeria) Ltd., and Conoco Energy Nigeria Ltd.	do.	7
Natural gas liquids	do.	Joint venture of Mobil Producing Nigeria Unlimited, 51%, and Nigerian National Petroleum Corp., 49%	Oso Field	15
Do.	do.	Joint venture of Chevron Nigeria Ltd., 40%, and Nigerian National Petroleum Corp., 60%	Escravos	3
Refinery products	do.	Port Harcourt Refining Co. Ltd. (Nigerian National Petroleum Corp., 100%)	Port Harcourt (new refinery)	55
Do.	do.	Warri Refinery and Petrochemicals Co. Ltd. (Nigerian National Petroleum Corp., 100%)	Warri	43
Do.	do.	Kaduna Refinery and Petrochemicals Co. Ltd. (Nigerian National Petroleum Corp., 100%)	Kaduna	38 4/
Refinery products	do.	Port Harcourt Refining Co. Ltd. (Nigerian National Petroleum Corp., 100%)	Port Harcourt (old refinery)	22 3/
Tin		Makeri Smelting Co. Ltd. (Government, 100%)	Jos	1

1/ One potline of the two-potline 193,000-metric-ton-per-year-capacity smelter was operating at yearend.

2/ Under construction.

3/ Idle during 1998.

4/ Undergoing rehabilitation, test runs only in 1998.

THE MINERAL INDUSTRY OF RWANDA

By George J. Coakley

The landlocked, 26,340-square-kilometer Central African nation of Rwanda is located between Tanzania and the Democratic Republic of the Congo [Congo (Kinshasa)]. In 1998, the population was estimated to be 8.1 million people, and the gross domestic product was estimated to be \$2.1 billion. The economy was predominantly agrarian. The civil unrest, violence, and population dislocations of the 1990's have been disincentives to new foreign investment.

The Rwandan mineral industry consisted mostly of a number of small cooperatives and individual artisanal miners that produced gold ores and concentrates of columbium (niobium)-tantalum, tin, and tungsten from scattered locations, generally in

a zone about 30 kilometers (km) wide extending east-west through Kigali. Cement was also produced. Mineral reserves data were not available.

Transportation complications constrained the nation's mineral exports. The Indian Ocean ports of Dar es Salaam, Tanzania, and Mombasa, Kenya, were about 1,500 km by truck and rail from Kigali. Rwanda's electricity generating capacity was about 25-megawatts.

For more extensive coverage of the minerals industry of Rwanda, see the 1994 Minerals Yearbook, Volume III, Area reports: International, pages 633-634.

TABLE I
RWANDA: PRODUCTION OF MINERAL COMMODITIES 1/

Commodity		1994	1995	1996	1997	1998
Cement e/	metric tons	10,000	10,000	42,000 r/ 2/	60,000 r/ 2/	50,000
Columbite-tantalite, ore and concentrate: e/						
Gross weight	kilograms	100,000	149,000 2/	99,000 r/ 2/	256,000 r/ 2/	250,000
Nb content	do.	34,000	40,000 2/	30,000	75,000 r/	75,000
Ta content	do.	22,000	28,000	25,000	50,000 r/	50,000
Gold, mine output, Au content	do.	1,000 e/	26	4 r/	13 r/	25 e/
Natural gas, gross e/	thousand cubic meters	970	970	970	100	100
Tin, mine output, Sn content	metric tons	50 e/	242	150 r/	75 r/	100 e/
Tungsten, mine output, W content	do.	30 e/	47	109 r/	57 r/	40 e/

e/ Estimated. r/ Revised.

1/ Includes data available through December 1, 1999.

2/ Reported figure.

THE MINERAL INDUSTRY OF

SÃO TOMÉ E PRÍNCIPE

By Philip M. Mobbs

The Democratic Republic of São Tomé e Príncipe, one of Africa's smallest nations, encompassing an area of 964 square kilometers, is about 275 kilometers west of Gabon in the Gulf of Guinea. The country's two islands and several islets support a population estimated to be 132,611 in 1997 and the gross domestic product was estimated to be about \$51 million¹ in 1996, the last years for which data are available (World Bank, 1998).

Mineral production was from small clay and volcanic rock open pit operations supplying a brick factory, a ceramics plant, and local construction needs. All other mineral products were imported.

Petroleum exploration was about to resume. In 1997, Environmental Remediation Holding Corp. (ERHC) of the United States and Procura Financial Consultants of South Africa were contracted to promote the country's hydrocarbon potential and to set up environmental programs. In July 1998, the São Tomé e Príncipe National Petroleum Co. (STPETRO) was formed as a joint venture of the Government (51%) and ERHC (49%). In September 1998, Mobil New Exploration Ventures Group, a subsidiary of Mobil Corp. of the United States, entered into an 18-month technical assistance agreement with STPETRO to explore on 22 offshore blocks. Mobil negotiated an option to acquire a production-sharing contract on the

acreage, apparently superseding an announced 1999 licensing round (Africa Energy & Mining, 1998; Yahoo, June 5, 1998, ERHC awards major contract to Schlumberger/Geco-Prakla for Sao Tome's lease sale offshore West Africa, accessed June 5, 1998, at URL http://biz.yahoo.com/bw/980605/enviroenmen_1.html). Mobil also contracted for Geco-Prakla, a subsidiary of Schlumberger Ltd. incorporated in the Netherlands Antilles, to begin a seismic survey in early 1999.

The water depths of São Tomé e Príncipe offshore exclusive economic zone ranged from 900 to 3,000 meters, but the country's maritime boundaries with Equatorial Guinea, Gabon, and Nigeria were ill-defined. São Tomé e Príncipe's location in the heart of the West African deepwater hydrocarbon exploration play could lead to years of exploration activity, given the high level of interest multinational oil companies have shown in deepwater prospects offshore Angola, Congo (Brazzaville), Equatorial Guinea, Gabon, and Nigeria (Knight and Westwood, 1999).

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Knight, Roger, and Westwood, John, 1999, Long-term prospects very bright for deep waters off West Africa: Oil & Gas Journal, v. 97, no. 3, January 18, p. 33-38.
World Bank, 1998, São Tomé and Príncipe—Statistical Appendix: Washington, DC, World Bank, 54 p.

¹Where necessary, values have been converted from São Tomé e Príncipe dobras (STD) to U.S. dollars at an average rate of STD1,933=US\$1.00 for 1996.

THE MINERAL INDUSTRY OF SENEGAL

By Philip M. Mobbs

The production of phosphate rock and fertilizers and gold exploration dominated the mineral industry of the West African nation of Senegal. Phosphate-related operations accounted for approximately 2% of the nation's gross domestic product.

The dispute concerning the Sabodala gold mine continued during 1998. Paget Mining Ltd. of Australia initiated a claim with the International Chamber of Commerce concerning its option agreements for the Société Minière de Sabodala (SMS), the company that held the Sabodala gold concession (Africa Energy & Mining, 1998). Paget was to acquire the Bureau de Recherches Géologique et Minières of France's (subsequently, LaSource Compagnie Minière) 50.64% equity interest in SMS. Paget also was to acquire 25.2% of the Government's equity interest in SMS. In 1997, however, LaSource sold its interest in SMS to Société d'Etudes et d'Exploitation Industrielles de l'Or en Afrique (Eeximore) of Senegal. Late in 1998, the Government halted the heap leaching of the concession's oxide ore, claiming that Eeximore's mining permit had expired in 1997 (Mining Journal, 1999).

Multinational exploration companies with interest in Senegal included African Selection Mining Corp. of Canada; the joint venture of AngloGold Ltd. of South Africa and Barrick Gold Corp. of Canada; the partnership of Ashanti Goldfields Co. Ltd. of Ghana and IAMGOLD Corp. of Canada (formerly

International African Mining Gold Corp.); and Etruscan Resources Inc. of Canada.

In 1998, Tolsa S.A. of Spain acquired the Société Sénégalaise des Phosphates des Thiès, a producer of attapulgitite and aluminum phosphate, from the Government and Rhône-Poulenc S.A. of France.

For more extensive coverage of the mineral industry of Senegal, see the 1996 Minerals Yearbook, Volume III, Mineral Industries Review of Africa and the Middle East, pages 111-112.

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Mining Journal, 1999, Senegal confusion: Mining Journal [London], v. 332, no. 8520, February 26, p. 131.

Major Source of Information

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TABLE 1
SENEGAL: ESTIMATED PRODUCTION OF MINERAL COMMODITIES 1/

(Thousand metric tons unless otherwise specified)

Commodity 2/	1994	1995	1996	1997	1998
Cement, hydraulic 3/	590 e/	694 r/	811 r/	854 r/	1,000 e/
Clays, fuller's earth (attapulgitite)	119	120	100 r/	80 r/	80
Petroleum:					
Natural gas thousand cubic meters	110,000	110,000	56,600 r/	56,000 r/	56,000
Crude oil thousand 42-gallon barrels	2	2	1 r/	1 r/	1
Refinery products do.	6,200	2,500	2,500	7,000 r/	7,000
Phosphate rock and related products:					
Calcium phosphate-based fertilizers	160	160	160	160	160
Crude rock:					
Aluminum phosphate	29	30 r/	30 r/	20 r/	20
Calcium phosphate	1,587 3/	1,500	1,340	1,300	1,300
Phosphoric acid	274	274	300	300	300
Salt	117	120	120	120	120

r/ Revised.

1/ Includes data available through September 1, 1999.

2/ In addition to the commodities listed, Senegal produced clays, sand and gravel, and stone for local construction purposes, limestone for cement, and artisanal gold. Information is inadequate to make reliable estimates of output levels.

3/ Reported figure.

THE MINERAL INDUSTRY OF SIERRA LEONE

By Philip M. Mobbs

The mineral production of the West African nation of Sierra Leone remained restricted by armed insurrection and political instability. The civil war had resumed in May 1997 after a military coup d'état. In March 1998, the elected Government was returned to power; however, fighting continued in the countryside. Diamond produced by persons collaborating with the ousted military junta and the Revolutionary United Front was reportedly smuggled out of the country, and resulting funds were allegedly used to support the rebels (Yahoo, May 6, 1998, Sierra Leone slaps ban on new mining permits, accessed May 11, 1998, at URL http://biz.yahoo.com/finance/980506/leone_mini_1.html). In May, the Government banned all mining. Artisanal recovery of diamond and gold was allowed to resume in July 1998 when revisions to the Mines and Minerals Act were announced (Mining Journal, 1998).

Many international mining companies had suspended exploration and production operations because of the war. Companies holding mineral concessions in Sierra Leone included AmCan Minerals Ltd. of Canada; Baomahun Gold Mines Ltd.; Bridge Energy Ltd., a subsidiary of DiamondWorks Ltd. of Canada; Golden Leo Resources Ltd., a subsidiary of Mano River Resources Inc. of Switzerland; Golden Prospect Mining Co. Ltd., a subsidiary of Golden Prospect Mining Co. Plc of the United Kingdom; Precious Stones Sierra Leone Baomahun Inc.; Prospex Mining Inc. of Canada; Resources Securities Ltd., a subsidiary of Golden Prospect Mining Co. Plc

of the United Kingdom; Rex Diamond Mining Corp. of Canada; Sierra Rutile Ltd., a joint venture of Nord Resources Corp. of the United States and Consolidated Rutile Ltd. of Australia; and White Swan Resources Inc. of Canada. Some companies, including Consolidated African Mining Corp. of Canada in 1997 and Pan African Resources Corp. of Canada in early 1998, abandoned mineral concessions in Sierra Leone owing to the war.

After the elected Government was reinstalled in March 1998, the Economic Community of West African States and the United Nations effectively lifted the naval blockade and sanctions imposed in 1997. Leocem, a joint venture of Scancem International AS of Norway and the Government, resumed importing cement clinker to grind in 1998, but renewed fighting forced the plant to close by yearend. The sanctions also had adversely affected the rehabilitation of the petroleum refinery owned by the West African Mining and Refining Co. Ltd.

For more extensive coverage of the mineral industry of Sierra Leone, see the 1996 Minerals Yearbook, Volume III, Mineral Industries of Africa and the Middle East, pages 113-114.

References Cited

Mining Journal, 1998, Sierra Leone lifts mining ban: Mining Journal [London], v. 331, no. 8490, July 24, p. 58.

TABLE 1
SIERRA LEONE: PRODUCTION OF MINERAL COMMODITIES 1/

(Thousand metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997	1998 e/
Bauxite, gross weight	735	--	--	--	--
Cement 2/	100 e/	100 e/	160	50	100
Diamond thousand carats	255	214	270	400 r/	250
Gold 3/ kilograms	125	4	16	20 r/ e/	15
Gypsum e/	4	4 r/	5 r/	2 r/	4
Salt e/	200	--	-- r/	-- r/	--
Titanium:					
Rutile ore and concentrate 96% TiO ₂ , gross weight	137	--	--	--	--
Ilmenite ore and concentrate 60% TiO ₂ , gross weight	47	--	--	--	--
Zircon metric tons	1,300	--	--	--	--

e/ Estimated. r/ Revised.

1/ Table includes data available through August 26, 1999.

2/ Production from imported cement clinker.

3/ Data includes only officially reported production.

THE MINERAL INDUSTRY OF

SOMALIA

By Philip M. Mobbs

The continued civil war and political instability since the overthrow of the Somali Government in 1991 has destroyed much of the economy. Mineral production presumably continued in a limited way despite the political situation, because construction material, salt, and sepiolite (meerschau) production was from small-scale artisanal operations throughout the country.

The Government of Somaliland, the self-declared republic in northwestern Somalia, invited foreign investment to the area. A foreign investment proposal submitted in 1997 was for the rehabilitation of the Berbera cement plant; however, the promised investment dissolved as 1998 progressed (Maroodi Jeex, Winter 1998, Egal's first foot steps in the private sector, accessed June 25, 1999, at URL <http://www.anaserve.com/~mbali/issue10t.htm>). In April 1998, Collins Engineering Co. of the United States and British-American Energy were contracted to repair the 25-megawatt power station in Hargeisa.

Infrastructure was rather limited. Bridges and roads destroyed by late 1997 floods in southern Somalia were being rebuilt. The United Nations Conference on Trade and

Development proposed to renovate the ports of Berbera and Bossaso in Somaliland (Journal of Commerce, 1998). Earlier in 1998, the attempt by the regional warlords to officially reopen the port of Mogadishu was aborted when the inaugural ship came under mortar fire while attempting to dock (George Sunguh, September 7, 1998, Reopening of Mogadishu port suffers major drawback, The East African, accessed September 11, 1998, at URL <http://www.nationaudio.com/News/EastAfrican/Current/Maritime/MA3.html>).

The economic difficulties facing wartorn Somalia are expected to continue until the political situation is settled.

For more extensive coverage of the mineral industry of Somalia, see the 1997 Minerals Yearbook, Volume III, Mineral Industries of Africa and the Middle East, pages 149-150.

Reference Cited

Journal of Commerce, 1998, UN group campaigns to rebuild Somali ports destroyed by war: Journal of Commerce, October 27, p. 4B.

TABLE 1
SOMALIA: ESTIMATED PRODUCTION OF MINERAL COMMODITIES 1/ 2/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997	1998
Cement, hydraulic	25,000	25,000	-- r/	-- r/	--
Gypsum	2,000	2,000	1,000 r/	1,000 r/	1,500
Limestone 3/	40,000	40,000	-- r/	-- r/	--
Salt, marine	1,000	1,000	1,000	800 r/	600
Sepiolite (meerschau)	5	6	6	6	6

r/ Revised.

1/ Includes data available through June 25, 1999.

2/ In addition to the commodities listed, various crude construction materials (e.g., clays, sand and gravel, crushed and dimension stone) and limestone for lime manufacture and/or agriculture are presumably produced; however, available information is inadequate to make estimates of output.

3/ For cement manufacture only.

THE MINERAL INDUSTRY OF SOUTH AFRICA

By George J. Coakley

Mining and downstream minerals processing remained keystones of the economy of the Republic of South Africa in 1998. With a population of 43.4 million, South Africa had a gross domestic product (GDP) per capita of \$6,800¹ based on purchasing power parity estimates for 1998. Of total exports of all goods valued at \$30.9 billion, gold exports accounted for 14.1%, and other minerals and metals exports, for about an additional 28%. The minerals industry, including mining and minerals processing through semimanufactured products, accounted for more than 6% of the GDP and more than 500,000 jobs. Employment in the mining sector, however, declined to 464,900 in 1998 from 603,700 in 1994; 97% of the cutbacks were in the gold mines. The most important mineral commodities produced in South Africa, in terms of value, were gold, coal, platinum-group metals (PGM), ferroalloys (ferrochromium, ferromanganese, ferrosilicon, and ferrovanadium), aluminum, steel, iron ore, diamond, vanadium, and copper. Additionally, significant output of metallic commodities included antimony, chromite, cobalt, lead, manganese, nickel, silver, titanium, uranium, zinc, and zirconium. Important output of industrial minerals included andalusite (aluminum silicate), aggregate and sand, asbestos, dimension stone, fluor spar, limestone and lime, phosphate rock, sulfur, and vermiculite. South Africa was a major producer and the world's third largest exporter of coal, and it was also the largest producer of synthetic liquid fuels and petrochemicals derived from coal. South Africa's well-developed railway and port infrastructure served the domestic minerals industry and those in neighboring countries. South Africa produced more than 62 different mineral commodities from about 695 mines and quarries, including about 61 coal mines and 54 diamond and 53 gold operations.

Government Policies and Programs

The Ministry of Mines and Energy's Department of Minerals and Energy (DME) is the primary Government entity responsible for the establishment and implementation of minerals and energy policy and for oversight of the country's mineral industry. Within the DME are the Mineral Development Branch, which is responsible for regional mineral development, minerals economics (Minerals Bureau), mine rehabilitation, and mining rights; the Energy Branch, which promotes the optimum utilization of energy resources; and the Mine, Health & Safety Inspectorate. A number of parastatal institutions were associated with DME, including the Atomic Energy Corp.; the Council for Nuclear Safety; the Council for Geosciences (formerly the Geological Survey of South Africa);

the Council for Mineral Technology (Mintek), the parastatal mineral-research organization; the National Electricity Regulator, the South African Diamond Board, and the CEF (Central Energy Fund) (Pty.) Ltd., through which the State's interest in the liquid fuel industry is owned, developed, and managed commercially.

The long-awaited Minerals and Mining Policy White Paper outlining a new minerals and mining policy for South Africa was released in October 1998 (Department of Minerals and Energy, 1998, A minerals and mining policy for South Africa, White Paper, accessed December 2, 1998, at URL <http://www.dme.gov.za/minerals/default.htm>); views of the White paper varied (Chamber of Mines of the South Africa, October 20, 1998, Mining and minerals policy in the new South Africa, National Policy Issues, accessed December 2, 1998, at URL <http://www.bullion.org.za/bulza/pgs/polindx.htm>). The White Paper focused on the freeing up of unexploited mineral rights long held by the major mining houses to provide more opportunities in the mining sector for black South African entrepreneurial groups and for foreign investment. This would be achieved through the Mineral Rights Tax, which would be written off by exploration expenditures, and exempt operating mines.

Subject to the adoption of a new minerals policy and implementing legislation by Parliament, the South African mineral industry operated under the Mining Titles Registration Act, 1967; the Central Energy Fund Act, 1977; the Petroleum Products Act, 1977; the Diamonds Act, 1986; the Electricity Act, 1987; the Mineral Technology Act, 1989; the Minerals Act, 1991; the Minerals Amendment Act, 1993; the Nuclear Energy Act, 1993; the Liquid Fuels and Oil Repeal Act, 1993; the Mineral and Energy Laws Rationalization Act, 1994 (which repealed the Mining Rights Act of 1967); and the Mine Health and Safety Act, 1996. A 1998 ruling by the Minister of Finance set the corporate tax rate at 35% for all companies entering offshore oil and gas subleases with Soekor (Pty.) Ltd. by the end of 1999. In 1998, the Government established a Gold Crisis Committee to monitor gold industry retrenchments and to study socioeconomic impacts and alternatives to mass retrenchments. The Committee is a tripartite commission of Government, labor, and industry representatives. The action was in response to the layoff of 135,000 gold miners during the past 5 years, and the threat of additional retrenchments as the South African gold industry struggles to remain competitive during a period of declining gold prices and historically high costs associated with deep underground mining.

Environmental Issues

Following the Consultative National Environmental Policy Process (CONNEPP), an initiative by the Department of

¹Where necessary, values have been converted from South African rands (R) to U.S. dollars at the rate of R5.53=US\$1.00 for 1998, and R4.61 = US\$1.00 for 1997.

Environmental Affairs and Tourism (DEAT) to review the state of the environment in South Africa, DEAT released its draft White Paper on Environmental Management Policy for South Africa in May 1997 (Department of Environmental Affairs and Tourism, July 1997, White paper on environmental management policy, accessed December 12, 1998, at URL http://www.polity.org.za/govdocs/white_papers/envir.html). The white paper confirmed the constitutional right to a healthy environment and established a policy of sustainable development as the accepted approach to resource management and use in South Africa. Enactment of the environmental management bill, proposed in the white paper, was expected in 1999. Separately, the DME was preparing to publish new regulations for the Environment Management Program (EMP) performance assessment and monitoring for the mining industry in 1999. The EMP was provided for in the Minerals Act, 1991, and chapter 4 of the Minerals and Mining Policy White Paper.

Production

In 1998, South Africa was one of the largest and most diverse minerals producers in the world. As shown in table 1, output levels were mixed. Gold production decreased a further 5% between 1997 and 1998 as a result of declining ore grades and high production costs associated with deeper mining. The gold industry was going through a major corporate restructuring involving ore reserve asset swaps and workforce reductions to cut production cost in response to declining world gold prices. Production of most of the other major metals were up from 1% to 8% compared with that of 1997. Output of cobalt, iron ore, and manganese declined. Within the industrial mineral sector, most production levels increased, with major declines seen in asbestos, which was being phased out as a result of environmental concerns, and barite. Domestic mineral commodity sales have been stimulated by a number of major industrial projects and the Government's residential home construction program. On a value basis, about 23% of primary mined products and 18% of processed mineral materials were consumed domestically. More than 70% of coal production went for internal power generation and for value-added synthetic fuel and petrochemicals production. Using South Africa's natural comparative advantage in possessing these resources, iron ore, chromite, manganese, and nickel also were converted to value-added ferroalloy and steel products for world markets.

Trade

In 1998, the total value of sales of primary minerals, as reported by the Minerals Bureau, was \$12.95 billion, of which \$10.01 billion was exported. The total value of all processed mineral materials was \$3.16 billion, of which \$2.59 billion was exported. The major exports by value in 1998 were gold at \$4.36 billion; PGM, \$2.10 billion; coal, \$1.75 billion, ferroalloys, \$1.11 billion; aluminum, \$660 million; iron ore, \$357 million; vanadium, \$227 million; and copper, nickel, and zinc, each more than \$100 million. Other significant exports, for which individual value data were not provided, included diamond, steel, titanium, and zirconium (Roux, 1999). With the help of new export-oriented and value-added aluminum, steel,

and titanium capacity, as well as expanded coal exporting capacity, the total value of primary and processed mineral exports has increased progressively (54%) to R69.66 billion in 1998 from R45.17 billion in 1994. This helped offset lower dollar-based sales resulting from the 56% devaluation of the rand versus the U.S. dollar during the same period.

The majority, by value, of primary mineral exports, including precious minerals, went to European markets, followed by the Pacific Rim countries, the Middle East and the Near East, and North America and Central America, with less than 10% each. Exports within Africa accounted for less than 1% of the South African mineral export trade.

Although South Africa was self-sufficient in the vast majority of its mineral needs, some mineral commodities were imported. Significant mineral imports included alumina, coking coal, rough and cut diamonds, certain ferroalloys, magnesite, magnesia, nickel, precious metals, and sulfur.

Structure of the Mineral Industry

The South African minerals and energy industries operated on a free enterprise, market-driven basis. Ownership of mineral rights was held by either the Government or private entities. Government involvement in these sectors was minimal and primarily confined to ownership of Eskom, the national electric power utility, and Southern Oil Exploration Co. (Soekor), the national oil and gas exploration company, including additional declining subsidies provided to synthetic fuels programs of Mossas (Pty.) Ltd. and Sasol Limited, two parastatals.

In South Africa, the bulk of mineral land holdings and production has been historically controlled by five mining investment houses—Anglo American Corporation (AAC) (including Johannesburg Consolidated Investment Limited (JCI)), Anglovaal Ltd., Gencor Limited (formerly General Mining and Finance Corp.), Gold Fields of South Africa (GFS), and Randgold and Exploration Co. Ltd. (formerly Rand Mines). Since 1994, the industry has been undergoing a major corporate restructuring, or “unbundling,” aimed at simplifying a complex system of interlocking ownership, establishing separate core-commodity-focused profit centers, and diversifying and rationalizing nonperforming assets to make the newly restructured companies more competitive internationally. During 1998, most of the corporate restructuring was completed, putting in place an entirely new industry structure.

AAC dominated the news with its October 15, 1998, announcement of plans to merge with Minorco S.A., its international coal and base metals subsidiary, to form a new company, Anglo American plc. Anglo American, the world's largest mining company, will shift its headquarters and primary stock listing from Johannesburg to London. Although the move was controversial in the eyes of the South African Government, it gives Anglo American access to the large international capital equity markets needed for global growth. De Beers Consolidated Mines Ltd., which had earlier severed its management ties with AAC, exchanged its 38.2% interest in AAC, its 22.5% interest in Minorco, and minority interest in several other nondiamond companies jointly held with AAC for shares equal to a 40% equity interest in the new company. Meanwhile, AAC transferred its interest in the diamond Central

Selling Organization to De Beers, while retaining a 33% interest in De Beers/Centenary through its 58% holdings in Anglo American Investment Trust. In addition to diamond interests held through De Beers, Anglo American plc had previously restructured its assets into a number of separate operating companies as follows. AngloGold Ltd. was formed in November 1997 from AAC's gold assets and from JCI's major gold mines at Western Areas Ltd. and H.J. Joel, creating the world's largest gold company with an annual production of 186,600 kilograms (kg) (6 million troy ounces) of gold and reserves, in all categories, of 4,354 metric tons (t) (140 million troy ounces) (Anglo American Corporation, 1998).

In July 1998, AngloGold subdivided its Vaal Reefs, Free State, Western Holdings, H.J. Joel, and West Wits gold mining complexes on a production shaft basis into 16 separate business centers, most of which were given new African names. The 16 gold mines, or profit centers, of which 14 were in South Africa, include the Great Noliqwa (formerly Vaal Reefs Shaft 8), Kopanang (formerly Vaal Reefs Shaft 9), Tau Lekoa (Vaal Reefs Shaft 10), Moab Khotsonk (Vaal Reefs Shaft 11), Bambanani (formerly Freegold Shaft 1), Tsepong (Freegold Shaft 2), Masimong (Freegold Shaft 3), Majhabeng (formerly Western Holdings), Joel, Western Deeps-East, Western Deeps-West, Western Deeps-South, Deelkraal, and Elandsrand. Also included were the Navachab Mine in Namibia and the Sadiola Mine in Mali. In December 1998, AngloGold also paid \$550 million to acquire Minorco's gold holdings in Argentina, Brazil, and the United States. Anglo American Platinum Corp. Ltd. (Amplats), formerly Rustenburg Platinum Holdings Ltd. and the world's leading platinum producer, was established to run the combined platinum-group metal assets of AAC and JCI. Anglo American Coal Corp. Ltd. (Amcoal) was then established to operate as the AAC coal subsidiary. Following the merger with Minorco in 1998, Anglo American Base Metals (Ambase) was established to handle the base metal interests of Anglo American.

In September 1998, JCI Ltd., the old mining house, was delisted from the Johannesburg Stock Exchange. In May 1995, AAC had unbundled its holdings in JCI into three separate companies: JCI Ltd., with interests in gold, ferrochrome, coal and base metals; Amplats; and Johnnies Industrial Corp. (Johnnic), containing its nonmining industrial holdings. JCI Ltd. was subsequently sold off to a black empowerment group, African Mining Group (AMG) (Capital Alliance). AMG ran into operating difficulties in 1997, and a decision was made to break up JCI Ltd. in September 1997. The company was restructured into two separate and autonomous base metal and gold companies, JCI Projects and JCI Gold. The gold assets, including Randfontein Estates Ltd., Western Areas Ltd., and H.J. Joel Ltd., were collapsed into JCI Gold. In November 1997, JCI Ltd. sold back to AAC its interests in H.J. Joel (60%) gold mine and of Western Areas (36.8%) gold mines and remaining interests in Amplats in exchange for De Beers' and AAC's 26% interest in Lonrho Plc. of the United Kingdom. In June 1998, JCI Gold created three separate and independent operating companies—Western Areas, Randfontein Estates, and Consolidated African Mines (CAM). Western Areas, which included Barnex Exploration and the South Deep gold project, had a 1998 production capacity of 11,200 kg (360,000 troy ounces) of gold and contained gold resources of 1,847 t (59.4

million troy ounces). In November 1998, a 50% interest in Western Areas was sold to Placer Dome Inc., a Canadian gold company, for around \$235 million. Randfontein Estates had a 1998 production capacity of 24,883 kg (800,000 troy ounces) of gold and contained measured, indicated, and inferred gold resources of 1,011 t (JCI Gold Ltd., October 1998, Presentation to Denver Gold Group—Mining Investment Forum, Slides 18, 19, and 35, accessed November 22, 1999, at URL <http://www.westernareas.co.za/>). CAM, established as a black economic empowerment vehicle focused on nongold mineral investment, was scheduled to merge with the remaining corporate part of JCI Gold. As part of its unbundling, JCI Ltd. sold its coal operations at Tavistock Collieries Ltd. to Lonrho's Duiker Mining Ltd. and its 57% interest in Consolidated Metallurgical Industries (CMI) chromite and ferrochrome operations to Metorex Pty. Ltd., while acquiring a 20% interest in Southern Mining Corp. and its Bothaville titanium deposit. Metorex was a subsidiary of Crew Development Corp., a Canadian company.

The megamerger of the gold assets of Gencor Ltd. and GFSA was finalized on February 2, 1998, creating Gold Fields Ltd., the world's second largest gold producer with an annual production of 93,300 kg (3 million troy ounces) of gold and gold minable resources of 2,538 t (81.6 million troy ounces) (Gold Fields Ltd., February 17, 1998, Results of the offers made by Gold Fields to shareholders of Evander and St. Helena, News—announcements, accessed June 1, 1999, at URL <http://www.goldfields.co.za/>). Operations were consolidated in South Africa under the Beatrix, the Driefontein, the Kloof, the Leeudoom, the Libanon, the Oryx, and the St. Helena Mines and in Ghana as the Tarkwa Mine. Gold Fields also retained the technical rights to the BIOX gold biological leach process. Gencor, which had previously consolidated all its nongold holdings into the London-based Billiton plc, was left with Impala Platinum Holdings Ltd. (Implats), the second largest producer of PGM in South Africa, as its only direct mining asset. GFSA continued to divest its nongold assets during the year, liquidating its copper-lead-zinc operations of Tsumeb Corp. Ltd. in Namibia and in South Africa, selling the O'okiep copper mine to Metorex, its coal and Gamsberg zinc deposit interests to AAC, its Zinc Corp. of South Africa Ltd. (Zincor) zinc refinery equity to Iscor Ltd., and its chromite reserves to Associated Manganese Mines of South Africa Ltd. (Assmang). GFSA will be delisted as a corporate entity in 1999 after returning an estimated 80% of its asset market value to shareholders.

In February 1999, Driefontein, Gold Fields, AngloGold, AAC, and Anglo American Gold Investment Company Limited announced a complex set of transactions that will further improve the competitive position of the South African gold mining industry and complete the restructuring of one of the industry's most important gold assets. Three transactions were announced, as follows:

- The acquisition by Gold Fields of AngloGold's entire interest of 21.5% in Driefontein at a price of about \$230 million. The action will give Gold Fields controlling interest in the Western Ultra Deep Levels ore body.
- The parallel stock swap between Gold Fields and AAC. This will increase AAC's equity interest in AngloGold to 53.7%.
- The proposed acquisition of Driefontein by Gold Fields. The new Gold Fields would wholly own, as its core assets, the

Beatrix, the Driefontein, and the Kloof gold mines, as well as 100% of the Leedoom, the Libanon, and the Oryx Mines, 70% of the Tarkwa gold mine in Ghana, and 54% of the St. Helena gold mine. The new Gold Fields will be the third largest gold producer in the world with an annual production of about 124,414 kg (4 million troy ounces) and total reserves of 2,986 t (96 million troy ounces) of gold (Gold Fields Ltd., February 8, 1999, [untitled], press release, accessed February 19, 1999, at URL <http://www.gfl.co.za/press/990218.html>). The Gold Fields/Driefontein merger was approved in May 1999.

Anglovaal Ltd. had completed its unbundling in 1996 with the formation of two companies, Anglovaal Gold Ltd. (Avgold) and Avmin, the latter to handle such nongold mineral investments as the Konkola North copper project in Zambia. In March 1998, Avgold purchased Fairview Consolidated Mines and its BIOX plant from Rand Gold for approximately \$16 million.

Rand Gold formed in July 1997 from Rand Mines to acquire and rehabilitate marginal cost mines, restructured its holdings into Durban Roodeport Deep Ltd. (DRD) and the London-listed Randgold Resources Ltd. DRD operated the Durban Roodeport Deep, the East Rand (ERPM), and the South Wits deep extension gold mines in South Africa. The Durban Roodeport Deep mining group represented the 1997 merger of three West Rand gold mines—Durban Deep, Blyvooruitzicht, and Buffelsfontein. Randgold Resources maintained an exploration and mining program in seven other African countries, including the Syama gold mine and the Loulo gold development in Mali and development of the Golden Ridge gold mine in Tanzania.

In September 1998, Harmony Gold Mining Co. Ltd., which was spun off by Rand Gold in 1997 as an independent company, acquired the Masimong Mine (formerly Freegold Shaft 3) from AAC for \$15 million and Gold Fields' 86% interest in the Evander group of gold mines (Kinross, Winkelhaak, Leslie, and Bracken) for \$93 million. The acquisition of Evander Gold Mines Ltd. increased Harmony's annual gold production capacity to nearly 40 t from 24.3 t and added an additional 311 t of proven and probable ore reserves (Gold Fields Ltd., June 24, 1998, Harmony acquires Evander, press release, accessed June 25, 1998, at URL <http://www.gfl.co.za/press/980624.html>). Harmony purchased the Bisset gold mine in Manitoba, Canada, sold its Consolidated Modderfontein and Grootvlei gold mines to Petra Mining Ltd. for nearly \$16 million, and obtained authorization from the Reserve Bank of South Africa to refine its own gold production by using a new solvent extraction hydrometallurgical process developed by Mintek.

The Chamber of Mines, whose members represent the majority of coal, gold, and uranium producers, was responsible for a variety of advisory and service functions for mining interests in South Africa. One of its main activities was the annual wage negotiations between member mines and the National Union of Mineworkers.

The largest foreign-owned mining group operating in South Africa was Rio Tinto plc. of the United Kingdom, which jointly owned with AAC the Palabora copper mine in northeastern Transvaal, one of the largest copper mines in the world. Rio Tinto was also a 50% shareholder in Richards Bay Minerals Ltd., a major world producer of mineral sands, with operations

in the coastal areas of KwaZulu-Natal Province. Further details of the structure of the minerals industry are shown in table 2.

Commodity Review

Metals

Aluminum.—Because South Africa has no economically exploitable deposits of bauxite and no alumina production capacity, all alumina feedstock for the production of aluminum metal was imported. Billiton Aluminium South Africa [formerly Aluminium South Africa (Pty.) Ltd. (Alusaf)] was the sole producer of primary aluminum from its Bayside smelter and the newer Hillside smelter at Richards Bay. Total production of aluminum metal increased by about 14% to 576,000 t in 1998. For the fiscal year ending June 30, 1998, the Hillside smelter produced 504,000 t of aluminum metal, and the Bayside smelter, 174,000 t. At Hillside, Billiton converted the bake and casthouse furnaces to gas from heavy oil to improve environmental performance and began an \$8 million upgrade of the casthouse. At Bayside, which Billiton planned to convert to value-added products, an \$18 million project to rebuild the Riedhammer furnace was approved.

Antimony.—Consolidated Murchison Ltd.'s operation at Gravelotte was South Africa's only producer of antimony (as stibnite concentrate); its output made South Africa the fourth largest producer after China, Russia, and Bolivia. In 1998, the world market price for antimony metal declined to a 40-year low, and several world producers cut back on production. Under new ownership, however, antimony production in South Africa increased by 24% to 4,243 t compared with that of 1997. Consolidated Murchison began to reactivate development of the Beta Shaft project at the Gravelotte operation in December 1998 and was continuing surface and underground exploration. The two operating shafts, Athens and Monarch, had 2 and 7 years of ore reserves remaining, respectively (Mining Journal, 1999).

Chromite.—Chromite ore production increased by 13% in 1998. South Africa was the global leader in chromite ore production and export. Production came from more than 20 mines located within the Bushveld Ultramafic Complex. About 86% of the ore went to supply domestic ferrochrome smelters, and the remainder was exported. Domestic consumption of chromite ore was the highest in the world, feeding the world's leading ferrochrome industry, as well as a world-class chromium chemicals and refractories industry. Chromite ore sales were valued at about \$165 million in 1998, of which about \$61 million was export revenue.

For the fiscal year ending June 30, 1998, Samancor Ltd. produced 3.2 million metric tons (Mt) of chromite ore, a 19% increase compared with that of 1997. At Samancor's Western Chrome mines, the Buffelsfontein Section was closed, with lost capacity being made up by expansion of the Mooiooi Section and by a new open pit operation on the Elandskraal ore body. At Samancor's Eastern Chrome mines, the Montrose Section was essentially depleted and scheduled for closure.

In early 1998, Südelektra Holdings AG of Switzerland (later renamed Xstrata Corp.) acquired Chromecorp Holdings Ltd. and CMI for \$179 million; Glencore International, a Swiss

metals trading company, was a major shareholder in Xstrata. This acquisition shifted the majority ownership of the South African ferroalloys industry to Europe. Xstrata combined the adjacent Rustenburg chromite mining operations of Chromecorp and CMI into one mining unit and began a feasibility study to expand the Thornecliffe Mine production to 1.0 million metric tons per year (Mt/yr) from 0.6 Mt/yr. At the Wonderkop Mine, development work was underway to return production capacity to 350,000 metric tons per year (t/yr) of salable chromite ore. In September 1998, Assmang paid nearly \$30 million to Gold Fields to acquire the assets of Dwarsrivier Farms Ltd. The new Assmang assets included a high-quality chromite deposit of 20 Mt of indicated mineral resource and an additional 200 Mt of inferred mineral resources (Avmin Ltd., 1998, p. 9).

Copper.—Copper mine production in South Africa increased by 8% in 1998. Palabora Mining Company Limited, by far the largest copper producer in the country, treated 28.8 Mt of ore grading 0.58% copper for the year, yielding 446,786 t of copper concentrates, containing 148,413 t of copper, the highest production in Palabora's history. Processed output included 119,042 t of copper. Palabora also produced 11,718 t of baddeleyite (70% of world demand), 289 t of nickel sulfate, 135,148 t of sulfuric acid, 104,950 kg of uranium oxide, 207,345 t of vermiculite concentrates, and 7,486 t of zirconium dioxide chemicals, as well as 11,546 kg of precious metals contained in 174 t of refinery tankhouse slimes. The Palabora Mine also generated 217,338 t of byproduct magnetite concentrates grading 61.7% iron and 1.6% titanium dioxide, which were either sold to the coal-washing industry or stockpiled for possible future use in a proposed new hot briquetted iron facility in Mozambique. Work progressed on schedule to transition from open pit to underground mining in 2002. Sinking of the exploration and service shaft was completed during the year; work on the production shaft expected to bottom out at nearly 1,000 meters (m) by August 1999. The \$380 million underground development project will extend the life of the mine for another 20 years, with production at a rate of 30,000 metric tons per day of copper ore (Palabora Mining Company Limited, 1999).

O'okiep, located in the North Western Cape Province, is one of the oldest mining districts in South Africa with aboriginal copper mining dating back to before 1685. Modern mining dates to 1846; O'okiep Copper Co. Ltd. was formed in 1937. Since 1937, 23 copper mines have been worked and depleted; the Carolusberg Mine was the most recent closure (1997). On October 7, 1998, Metorex purchased an 81.47% interest in O'okiep Copper from Gold Fields for a cash consideration of more than \$5 million. Nigraemoep, the only mine operating in 1998, used a modified vertical crater retreat mining system to mine 65,000 metric tons per month (t/mo) of ore in three shifts with production scheduled to be increased to 80,000 t/mo of ore in 1999. Mineralization occurred chiefly as disseminated bornite within a norite host, associated in places with chalcopyrite and digenite. The Nigraemoep Mine had about 7 years of reserves remaining; exploration and mine feasibility studies continued to assess two deeper deposits, the Flat Mine South and the Flat Mine East. In 1998, O'okiep milled 711,324 t of ore grading 2.20% copper, producing a concentrate grading

40.41% copper, with a contained copper content of 14,571 t, an 11% increase compared to that of 1997. The smelter had a capacity of approximately 35,000 t/yr of copper metal and required the acquisition of 40,000 to 50,000 t/yr of toll or custom smelting concentrate to supplement available in-house concentrate.

Copper was also produced in small amounts as a byproduct of lead-zinc and platinum mining.

Gold.—The continued unbundling of assets by major South African mining companies was the main highlight for the gold industry during the year. Faced with dropping ore grades and the increasing cost of deep mining, the gold industry continued its steady decline. In 1998, mine production was 464 t of gold with an average grade milled of 5.09 grams per ton (g/t) gold. This was 5% lower than that of 1997, but significantly lower than the historical peak production year of 1970 when 989 t of gold was produced at an average grade milled of 13.28 g/t gold. South Africa remained the world's leading gold producer, although its once-dominant share of total global new mined gold production dropped to 19% in 1998 from 68% in 1970 (Chamber of Mines of South Africa, 1998, Online statistical tables—1997/98, accessed February 20, 1999, at URL <http://www.bullion.org.za/panl/wmain2.htm>). Gold prices, which were at a 20-year low in 1998, as well as restructuring and streamlining of the South African gold industry, contributed to decreased gold output. The industry was making significant efforts to reduce operating costs, to improve productivity, to optimize reserve development by asset swaps of ore reserve holdings with neighboring mines, and to help stabilize production levels. The number of gold mines in a marginal position declined to five mines in 1998, representing 50 t of gold production and an employment level of nearly 28,000 workers, from nine mines in 1997 (Chamber of Mines of South Africa, 1999, Economic review, Annual report—1998/99, accessed December 12, 1999, at URL <http://www.bullion.org.za/bulza/publications/99AnReport.pdf>).

Capital investment within the gold industry in 1998 was about \$380 million. In South Africa, where the extreme depths of new deposits add several years to underground development time, four major new gold projects continued on track—Avgold's Target project, Western Area's South Deep project, AngloGold's Moab project, and Gold Fields's developing Oryx Mine. Oryx, which was commissioned in 1996, reached more than 80% of operating capacity in 1998 and was expected to produce at full capacity of 10,550 kilograms per year (kg/yr) of gold in 1999. AngloGold was also considering plans to develop its experimental Western Ultra Deep Levels project that would run a single shaft to a depth of 5,000 m to access resources containing 1,500 t of gold at a grade of 10 g/t gold (Business Day, September 8, 1997, Deepest mine yet will stretch technology to the limit, accessed September 8, 1997, at URL <http://www.bday.co.za/97/0908/company/c7.htm>).

Iron and Steel.—Iron Ore.—In 1998, iron ore production in South Africa decreased to 32.97 Mt, or about 1% from that of 1997. Of total sales of iron ore in 1998 of 33.75 Mt, valued at about \$450 million, 65% was exported, and 35% was shipped to domestic steel plants. Iscor was South Africa's largest iron ore

producer. Its two iron mines, Sishen and Thabazimbi, accounted for more than 80% of the country's total output. The Sishen Mine in the Northern Cape Province has the capacity to produce about 25 Mt/yr of iron ore grading 65% iron, and the Thabazimbi Mine in the Northern Province, 2.9 Mt/yr of iron ore grading about 60% iron.

Iron and Steel.—South African crude steel production dropped by 9% in 1998 owing, in part, to operational problems at Columbus Stainless early in the year. Iscor's production dropped to 6.48 Mt but still accounted for more than 80% of the country's total crude steel production. Iscor remained the largest steel maker in Africa. The highlight of the steel industry in 1998 was the commissioning of Saldanha Steel (Pty) Ltd.'s \$1.5 billion export-oriented steel plant at Saldanha Bay about 140 kilometers (km) northwest of Cape Town. Saldanha Steel was a joint venture between Iscor (50%) and the state-owned Industrial Development Corporation (IDC) (50%). The first shipment of hot-rolled steel coil was made in August 1998, and the project was fully commissioned with the first products from the Corex and Direct Reduction units in January 1999. This was the world's first steel minimill to combine the Corex and the Midrex technologies (replacing blast furnace technology) and was designed to be environmentally clean. Saldanha Steel will reach full production capacity of 1.25 Mt/yr of hot-rolled coil steel by the end of 1999. The design layout was planned to permit a doubling of capacity in the future. The plant will use iron ore pellets instead of scrap, and while initial feed is being imported, the plant will be supplied from Iscor's Sishen iron ore mine. At full operation, the plant will consume 950,000 t/yr of iron ore for the Corex plant, 850,000 t/yr of direct reduced iron for the Midrex plant, 850,000 t/yr of coal, and 228,000 t/yr of metallurgical dolomite. The rolling mill had the capacity to produce 2 Mt/yr of hot-rolled steel coil rolled to a final thickness of 1.0 to 8.5 millimeters. Approximately 67% of production will be directly exported as hot-rolled coil, with the remaining 33% sent to the adjacent Duferco Steel Processing Ltd. cold-rolling slab plant where it will be cold rolled into thinner slabs. The Duferco processing also will include pickling, oiling, and galvanizing stages (Saldanha Steel (Pty.) Ltd., 1999, *Our process, and Milestones*, accessed April 20, 2000, at URL <http://www.ssteel.co.za>).

Weak global steel markets, particularly in Asia, forced South African producers to cut back on production capacity by yearend and subjected them to antidumping actions by the United States. During the year, Iscor decommissioned its 45-year-old Hot Strip Mill South and Blast Furnace B at its Vanderbijlpark Works and mothballed the ironmaking facilities at its Pretoria Works, thus freeing up 500,000 t of iron ore for export. Highveld Steel and Vanadium Corp. Ltd. (Highveld) also closed two of its seven steel-processing furnaces.

In response to complaints that alleged unfair trade practices were actually hurting the U.S. steel industry by U.S. steel producers, the U.S. Department of Commerce (DOC) in October imposed a high 31.8% dumping duty on stainless steel plate exported by Columbus Stainless. The duty was based on calculations of the difference between the transport-adjusted price of Columbus Stainless's product in the United States and the higher amount it had been charging at home. The duty came on top of a 2.1% countervailing duty assessed by the United States in August 1998 in response to allegations that Columbus

Stainless was receiving unfair Government subsidies. The DOC actions were subject to a final determination by the U.S. International Trade Commission. Iscor's sale of cold-rolled steel to the United States was also expected to be impacted by the increased countervailing duties (U.S. International Trade Administration, 1998, 1999).

Ferroalloys.—For 1998, ferrochromium production increased by 4% to more than 2 Mt compared to that of 1997. Total export volume for South African ferrochrome was 1.65 Mt valued at \$699 million. Other ferroalloy production and sales included manganese alloys, production of 847,000 t, and sales of 858,000 t valued at \$383.7 million, of which 85% was exported, and silicon alloys, production of 165,700 t and sales of 170,800 t valued at \$128 million, of which 58% was exported (Roux, 1999).

In two yearend 1998 moves, Billiton and Anglo American cemented their roles as major players in the world ferroalloys industry by joint venturing to purchase outstanding minority shares of Samancor's South African ferrochromium operations for \$200 million and by purchasing Broken Hill Proprietary Co. Ltd.'s Australian manganese operations for \$375 million. When the transactions are complete, Billiton and Anglo American will control 60% and 40% equity interest, respectively, in both mining and ferroalloy companies. Billiton picked up about 1.8 Mt in manganese ore and 200,000 t in manganese ferroalloy capacity through the BHP Manganese acquisition (Mining Journal, 1998).

Billiton's main competitor in the ferroalloys industry became Xstrata. As the world's two largest producers, these two companies each controlled more than 1 Mt/yr of ferrochrome capacity. Xstrata, which had previously acquired the South Africa vanadium producer, Rhoex Pty. Ltd., was also South Africa's second largest vanadium pentoxide producer after Highveld. In 1998, Xstrata reported production of ferrochromium of 588,825 t at Chromecorp and 391,090 t at CMI; plans were to increase ferrochrome production capacity at CMI to 460,000 t/yr. Samancor commissioned a new \$56 million pelletizing plant at its Ferrometals Division, which will add an additional 60,000 t/yr of ferrochrome capacity (Mintek, August 28, 1998, *Ferroalloys*, BusInfo, accessed February 9, 1999, at URL <http://mintek.co.za/businfo/Businfo19980828.htm>).

Lead and Zinc.—In South Africa, Anglo American consolidated its position in the lead-zinc industry by purchasing GFSA's 55% share and Phelps Dodge Corp.'s 45% share in Black Mountain Mineral Development Co. (Pty.) Ltd., a base metals producer, and by announcing planned investments of \$720 million to develop the Gamsberg zinc mine, mill, and smelter project, which would have the capacity to produce 200,000 t/yr of refined zinc. The Gamsberg deposit, located 22 km from Black Mountain in Northern Cape Province, contains a resource of 90 Mt grading about 6.4% zinc. The deposit has a high manganese content, making the extractive metallurgy difficult. Anglo American was examining the potential to use the direct-current plasma-arc smelting technology currently (1998) operational at its Namakwa Sands titanium plant in Saldanha Bay to treat the Gamsberg zinc ore (David McKay, September 8, 1998, *Anglo to develop R4bn zinc mine*, Business Day, accessed September 9, 1998, at URL <http://www.bday.co>).

za/98/0908/news/news2.htm).

In October 1998, as part of its divesting of nongold assets prior to its merger with Gencor, GFSa sold its 65% interest in the Zincor zinc smelter to Iscor for around \$44 million. Zincor, currently (1998) the only producer of refined zinc in southern Africa, produced 107,400 t of zinc metal and 166,412 t of sulfuric acid for the financial year ending June 30, 1998 (WOZA, October 21, 1998, Gold Fields sells Zincor to Iscor, WOZA online news, accessed July 8, 1998, at URL <http://www.woza.co.za/mining/zincoro.htm>).

Billiton's and IDC's plans to build a new zinc smelter at Ngqura port, near Port Elizabeth, Eastern Cape, were set back in December when the Japanese partners, a consortium led by Mitsui Mining and Smelting Company, withdrew from the project. While continuing to seek new technical partners, Billiton proceeded with studies needed to develop the \$560 million 250,000-t/yr zinc smelter (T.H. Zwane, 1998/99, Zinc, South Africa Minerals Bureau, accessed October 12, 1999, at URL <http://www.dme.gov.za/minerals/zinc.htm>).

Manganese.—South Africa possessed the world's largest resources of manganese ore, reported to be 12 billion metric tons, and challenged China as the world's largest producer (Samancor Ltd., 1998, Manganese—Ores, accessed September 22, 1998, at URL <http://www.samancor.co.za>). In 1998, South Africa produced 3.04 Mt gross weight of manganese ore and concentrates, primarily metallurgical grades ranging from 30% to more than 48% manganese. Samancor accounted for about two-thirds of the national production from its Mamatwan open pit and Wessels underground mines near Hotazel; production of manganese ore decreased by 9% to 2.1 Mt in 1998 compared with that of the 1997 fiscal year ending June 30. Samancor was upgrading the Sinter Plant at a cost of \$17 million. About 40% of Samancor's manganese ore production was exported to ferroalloy producers worldwide. The remainder was converted into alloys at Samancor's Manganese Division works at Meyerton, Gauteng, and into manganese metal by the Manganese Metal Co. Pty. Ltd. The Manganese Division, in turn, exported 85% of its production.

Assmang was the other major producer with sales of just under 1 Mt in 1998. Both companies had downstream ferromanganese- and silicomanganese-processing facilities.

Nickel.—South Africa's nickel production was in the form of metal, metal-in-concentrate, and sulfate. The nation's nickel output, which has primarily been produced as a byproduct of PGM and copper processing, was supplemented by primary production from the new Nkomati nickel mine during its first full year of production in 1998. Domestic sales of nickel in 1998 amounted to about \$73 million; export sales of nickel were valued at more than \$112 million. The Nkomati Joint Venture, controlled by Avmin (75%), continued on track with its Nkomati nickel mine, which yielded about 3,000 t/yr of nickel in concentrate. Nkomati brought the \$35 million MSB Mine, a small, high-grade portion of the area nickel resource, into production in January 1997 at a rate of 10,000 t/mo run-of-mine ore, yielding 3,000 t/mo of concentrate containing an average of 210 t nickel, 67 t of copper, 4 t of cobalt, 4.9 kg of platinum, and 14.4 kg of palladium. The feasibility study on expanding mining operations to include the large low-grade

reserve base in three adjacent ore bodies continued.

Platinum-Group Metals.—South Africa's production of PGM, which originated almost exclusively from mines in the Bushveld Complex north of Pretoria, accounted for a dominant share of world production of these commodities in 1998, including platinum (80%), palladium (47%), and rhodium and other PGM (77%). Additionally, South Africa possessed around 88% of the identified global reserve base of PGM.

In 1998, South Africa produced 200,143 kg of PGM and exported 183,510 kg valued at \$2.1 billion. Export shipments included 114,461 kg of platinum, 56,608 kg of palladium, and 12,441 kg of rhodium. The 100% price rise in rhodium and 60% rise in palladium and shortfalls in Russian PGM production and exports during 1998 were major incentives for South African producers to expand production.

Amplats was the largest PGM producer in the world at about 37% of global platinum supply, all from South African operations. Amplats production came from three operating subsidiaries—Rustenburg Platinum Mines Ltd. (RPM), Potgietersrust Platinums Ltd. (PPRust), and Lebowa Platinum Mines Ltd. (Leplats) in Northwest and Northern Provinces. In its annual report for the year ending June 30, 1998, Amplats outlined three major expansion projects. RPM was spending \$160 million to develop the Bafokeng Rassimone platinum mine at Boschkoppe in the western part of the Bushveld Complex. The mine was expected to be in full production in 2002 at a rate of 7,776 kg/yr of refined platinum. The Bafokeng Rassimone Mine development was based on probable underground reserves in the Merensky Reef of 53 Mt grading 7.34 g/t platinum-group elements (PGE) and in the UG2 chromite layer of 76.4 Mt grading 4.91 g/t PGE. An additional 1.5 Mt grading 6.13 g/t PGE within the Merensky Reef is accessible for open pitting. During fiscal year 1998, Amplats milled 21.4 Mt of ore from all operations with an average head grade of 5.56 g/t PGE. PPRust invested more than \$55 million to expand the mine's concentrator capacity to 425,000 t/mo from 250,000 t/mo. This would allow an increase of an additional 1,555 kg/yr in refined platinum production by the end of 1998. Leplats will invest \$12 million to open the near surface Middlepunt Hill UG2 deposit at Atok. The mine, which will take 18 months to complete, will process 30,000 t/mo at a head grade of 5.12 g/t PGE, adding 653 kg/yr of refined platinum to Leplats' capacity. Amplats total corporate refined production included 59,047 kg of platinum, 29,533 kg of palladium, and 5,421 kg of rhodium. As of June 30, 1998, Amplats ore reserves within the Merensky Reef and Platreef were 99 Mt of proven reserves grading 6.31 g/t PGE, 412 Mt of probable reserves grading 5.61 g/t PGE, and 167 Mt of indicated reserves grading 4.9 g/t PGE. Within the UG2 chromite layer, Amplats reported 37 Mt of proven reserves grading 5.19 g/t PGE, 598 Mt of probable reserves grading 5.61 g/t PGE, and 1.2 Mt of indicated reserves, grading 5.3 g/t PGE (Anglo American Platinum Corp. Ltd., 1998, p. 68-107).

Implats, the second largest producer in South Africa, operated 13 shafts within the Merensky and the UG2 Reefs, a concentrator, smelter, and an enhanced precious-metals refinery, producing 32,721 kg of platinum, 17,325 kg of palladium, and 3,484 kg of rhodium, for the financial year ending June 30, 1998. Between 1998 and 2000, Implats

planned on investing more than \$200 million to install a new decline shaft and to upgrade concentrating and smelting facilities. During early 1999, Implats resolved a longstanding dispute with the Royal Bafokeng Nation with a stock and royalty settlement that will give Implats access to mineral rights on Bafokeng land that will allow it to maintain mining rates at or more than 32,400 kg/yr of platinum for at least 30 years. Impala reported total mineral reserves as of June 30, 1999, of 210.6 Mt grading 5.15 g/t PGE and mineral resources of 223.7 Mt grading 8.5 g/t PGE (Impala Platinum Holdings Ltd., 1999, p. 22).

Lonrho Platinum operated three mines, a smelter, a base metals smelter, and a precious-metals refinery. For the financial year ending September 30, 1998, Lonrho mined and treated 9.2 Mt of ore, yielding a refined production of 19,518 kg of platinum, 9,054 kg of palladium, and 2,743 kg of rhodium. Estimated proven and probable in situ minable reserves were reported to be 335 Mt grading 5.9 g/t PGE (Lonrho Platinum, 1999, p. 40). Lonrho's strategic plan called for maintaining an average production growth of 1.5% for the next 25 years, which will involve the sinking of additional major vertical shafts, beginning in 2000, to replace the current (1998) Westplats South operation and the Eastern Platinum Incline Shafts. A shift of mining from the Merensky Reef to the higher grade UG2 ore reserves had already begun.

Aquarius Platinum Ltd. of Australia, a new entrant to the PGM sector, controlled the Marikana deposit, containing a PGM-bearing resource of 20 Mt, and the new Kroondal platinum mine development in North West Province. Implats also held a 45% interest in Kroondal Platinum Mines Ltd., which expected to start up production by July 1999. The Kroondal operation will produce at a rate of 3,110 kg/yr of platinum, 1,555 kg/yr of palladium, and 467 kg/yr of rhodium, all in concentrates, that will be sold to Implats for refining. Capital costs were \$56 million. Reserves were sufficient for 14 years of operation at this rate. Measured reserves in two seams were reported to be 2.6 Mt grading 5.8 g/t PGE and indicated reserves to be 13.3 Mt grading 6.3 g/t PGE. Unlike the meter-high mining panels used elsewhere in South African platinum mines, Kroondal will use a "wide reef" concept, digging tunnels big enough for mechanical equipment and for miners to stand up straight. Waste will be separated by a gravity system on the surface before the ore goes to the mill for grinding (Jones, 1999).

Titanium and Zirconium.—Globally, South Africa ranked second in titanium production and third in titanium exports in 1998. Richards Bay Minerals, owned jointly by Rio Tinto and Billiton, produced ilmenite, rutile, and zircon from beach sands north of Richards Bay. Richards Bay Minerals was the trading name for two registered companies—Tisand (Pty.) Ltd. and Richards Bay Iron & Titanium (Pty.) Ltd. (RBIT). Tisand was responsible for the dune mining operation and mineral separation, and RBIT undertook the smelting and beneficiation process. RBIT produced an 85% titanium dioxide slag from ilmenite concentrates at the Richards Bay smelter, as well as low-manganese pig iron. The flow sheet for the operation was available on the company web site accessible at URL <http://www.richardsbayminerals.co.za>. The Richards Bay

operation was the largest titanium mineral producer in the country, with production exceeding 1 Mt of titanium dioxide slag in 1998. RBM was investing \$150 million to develop a new mine site, Pond-E, north of existing operations, and to upgrade the existing mineral-processing plant. The expansion project, which should be operational by late 1999, will permit RBM to maintain slag output of 1 Mt/yr as ore grades gradually decline (Billiton plc, 1998, p. 15-37).

Namakwa Sands Limited operated a heavy minerals sand mine at Brand-se-Baai and a mineral separation plant at Koekenapp, located 340 km northwest of Cape Town, and a smelter at Vredenburg, near the export harbor at Saldanha Bay. The project was being developed in two phases by the owners, Anglo American (80%) and De Beers (20%); IDC provided an \$80 million loan. Since the startup of Phase I in 1994, the operation has mined 4 Mt/yr of ore yielding approximately 400,000 t/yr of heavy medium concentrates with an average composition of 55% ilmenite, 15% zircon, 4% rutile, 16% other heavy minerals, and 10% quartz. The smelter, using Mintek-developed direct-current plasma-arc technology, produced titanium slag and a coproduct pig iron from ilmenite concentrates. Planned Phase I production rates were 56,000 t/yr of pig iron, 36,000 t/yr of rutile, 97,000 t/yr of titanium slag, and 123,000 t/yr of zircon. Actual 1998 production, however, was lower owing to lost time resulting from an explosion in the main furnace, which has since been repaired. The \$220 million Phase II expansion began in 1997 and was expected to be completed by 2001. Mining and ore treatment will expand to 12 Mt/yr. A second direct-current plasma-arc furnace, commissioned in March 1999, will double slag output. Production at full capacity will be 230,000 t/yr of high titanium slag, 140,000 t/yr of zircon, 120,000 t/yr of pig iron, and 42,000 t/yr of rutile, generating an expected total export revenue of about \$190 million per year on the basis of 1998 exchange rates (Personal communications, February 1999).

Titaniferous magnetite also was recovered at the Phalaborwa carbonatite as a byproduct of copper and phosphate rock production, and titaniferous slag was produced from Mapoch Mine magnetite ores at Highveld's Witbank steel plant. Additionally, research was carried out during the year to recover titanium dioxide from the massive slag heap at Highveld. The slag heap contained 30% titanium dioxide. Current (1998) technologies, however, are incapable of recovering the material economically (Mining Journal, 1999).

In 1998, South Africa ranked second worldwide in the production and export of zirconium minerals. Zirconium was produced as a zircon byproduct of mining at the Richards Bay and the Namakwa Sands mineral sands operations. Palabora produced 70% of the world's baddeleyite, which is a zirconium sulfate mineral used in specialized applications in the ceramics, refractory, and tanning industries and in kidney dialysis machines. Sales of all zirconium products at Palabora fell to 7,486 t compared with 9,387 t in 1997, principally owing to reduced access to ore as the open pit narrows. Palabora produced only 263 t of zirconium basic sulfate (ZBS) from zircon sands at its new plant in 1998. Full production capacity was expected to be 7,895 t/yr of ZBS product containing 38% ZrO_2 by 1999 (Palabora Mining Company Limited, 1999, p. 7-8).

Uranium.—In 1998, uranium oxide production decreased to 1,138 t from the 1,324-t output in 1997. Uranium was produced as a byproduct from the Vaal Reefs and the Hartbeestfontein gold mines and the Palabora copper mine, which produced 105 t in 1998. More than 90% of uranium oxide production was as a byproduct of gold mining. The gold industry treated 4.81 Mt of material grading 221 g/t of uranium oxide and yielding 1,061 t of uranium oxide.

Vanadium.—South Africa was the world's largest producer and exporter of vanadium. Vanadium was produced from titaniferous magnetite mined from the Bushveld Complex. The largest producer was Highveld with an annual capacity of 50,000 t of vanadium pentoxide. Highveld's main products were vanadium slag and vanadium pentoxide flake, although modest amounts of vanadium trioxide also were produced, as was a small amount of ferrovanadium. Xstrata was the second largest South African producer of vanadium, having acquired Rhoex and Vanadium Technology (Pty.) Ltd. (Vantech) in 1997. During 1998, Rhoex, with its new leaching facility in place, produced 5,579,193 kg of vanadium pentoxide (V_2O_5), a 48% increase compared with that of 1997. Xstrata planned another \$5 million investment to upgrade the crushing and milling process at Rhoex. Xstrata reported an 11% increase in production at Vantech to 5,805,989 kg of V_2O_5 and announced a prefeasibility study to examine development of the Steelpoortdrift vanadium deposit. Xstrata reported that its South African vanadium resources were 22.02 Mt of proven reserves grading 0.71% V_2O_5 , 18 Mt of probable reserves grading 0.63% V_2O_5 and 130.83 Mt of inferred resources grading 0.94% V_2O_5 (Südelektra Holding AG, 1999, Annual report for 1998, accessed January 20, 2000, at URL http://www.xstrata.com/reports/doc/sue-ar1998_en.pdf).

Industrial Minerals

South Africa produced about 33 different industrial minerals from 467 mines and quarries. The industrial minerals sector was a significant contributor to total mineral sales in 1998. The value of total sales of industrial minerals produced was about \$717 million. Approximately 72% of those sales was on the domestic market. In terms of sales, the three dominant industrial mineral commodities were aggregate and sand, limestone and dolomite, and phosphate rock. The largest domestic consumers of South Africa's industrial minerals were the building and construction, metallurgical, and agricultural sectors. Total export earnings for industrial minerals were more than \$200 million in 1998. Granite and norite dimension stone accounted for 51% of industrial mineral exports, with the other major export commodities being, by value, phosphate rock, andalusite, vermiculite, fluorspar, and asbestos (Roux, 1999).

Diamond.—Spurred by new entrants into sector, rough diamond production increased by 7% to 10.76 million carats in 1998. As in years past, mines owned by De Beers dominated the sector with more than 90% of the total production. Total diamond production for De Beers' South African operations in 1998 amounted to 9.65 million carats recovered from 22.9 Mt of material treated. The Venetia Mine, the largest De Beers operation, recovered 4.5 million carats; the Finsch Mine, 2.17

million carats; the Premier Mine, 1.39 million carats; the Namaqualand Mine, 768,480 carats; the Kimberley Mine, 682,924 carats; and the Koffiefontein Mine, 158,480 carats. Diamond recovery rates varied considerably within the De Beers operations, with Venetia recovering 135.2 carats per metric ton, Finsch, 54.5 carats per ton, Premier, 45.5 carats per ton, the Kimberley Mine, 16.4 carats per ton, the Namaqualand Mine, 12.5 carats per ton, and the Koffiefontein Mine, 6.9 carats per ton (De Beers, 1998). At Kimberley, De Beers was examining the feasibility of extending the life of the Dutoitspan Mine by 6 years by replacing its 40-year-old treatment plant with a newer, more efficient technology that would permit recovery from old surface dumps and previously uneconomic underground reserves.

The sharp drop in demand and prices for diamonds, accounted for, in part, by the financial crisis in Asia, led De Beers to begin cutting back production at some South African operations by yearend. In October, however, De Beers announced that it was considering investing \$230 million to expand the production capacity at the Premier diamond mine to about 3 million carats per year. Development of the so-called "C-Cut" at Premier would access reserves between 750 and 1,000 m and extend the life of the mine from 12 to 32 years. At the Venetia Mine, optimization of the pit design and ore haulage equipment selection will permit the open pit mine to reduce through the 400-m level until about 2020.

SouthernEra Resources Ltd. of Canada brought the Sugarbird Blow Mine at Klipspringer and the Marsfontein property, near Potgietersrust in Northern Province, into production after a lengthy legal battle over ownership of the mining rights; 60% will go to De Beers who bought out the original owner. The Marsfontein joint venture treated 116,000 t of material in its first year of operation, yielding 533,337 carats of diamonds. The unusually high recovery at Marsfontein was attributed to enriched secondary gravels overlying the main M1 kimberlite ore body. In February 1999, De Beers sold its 60% interest in the Marsfontein property to a black empowerment group comprising New Diamond Corp., Domba Investments, and Vuwani Projects for \$36 million. SouthernEra commissioned its \$8.5 million dense medium separation plant at Klipspringer in February 1998. In addition to the Marsfontein production, the Klipspringer Plant treated 85,537 t of ore from the Sugarbird Blow, yielding 68,166 carats of diamonds. Exploration by SouthernEra in the Klipspringer area since 1995 has identified a complex fissure system containing 10 mineralized kimberlite bodies. Besides Marsfontein, development work on two of the kimberlites, at the Sugarbird Blow and at the underground Leopard Fissure, was underway in 1998.

Fluorspar.—Phelps Dodge owned and operated the Witkop open pit fluorspar mine and a mill in the western Transvaal during most of 1998. Witkop produced a total of 101,800 t of acid-grade fluorspar in 1998 compared with 97,800 t in 1997. Acid-grade fluorspar concentrates were shipped to customers in South Africa, the United States, Europe, Australia and Asia. In late 1998, the Witkop Mine was sold to the Australian-owned South Africa Land & Exploration Company (Sallies). Sallies planned on upgrading the metallurgical process at the plant to return it to its full capacity of 120,000 t/yr of fluorspar.

Vermiculite.—Production of exfoliated vermiculite increased by 5% to 221,300 t in 1998, representing about 75% of reported world supply, compared with that of 1997. The major producer was the Vermiculite Operations Division of Palabora, which extracted vermiculite from the pyroxenite units of the mineralogically diverse Phalaborwa Carbonatite Complex. The company reported vermiculite concentrate production of 207,070 t grading 90.74% vermiculite (Palabora Mining Company Limited, 1999). Vermiculite production at the Natkrut Vermiculite Mine Pty. Ltd. mine and beneficiation plant in the Northern Province was at a rate of about 14,000 t/yr of unexfoliated vermiculite; the mine closed in March 1999.

Mineral Fuels

Coal.—Following gold, coal was one of the most important sectors of the mineral economy of South Africa. South Africa remained the fifth largest coal-producing country in the world and the third largest coal exporter. Production and export levels continued on an upward trend in 1998. Of the 223.6 Mt of coal produced in 1998, valued at \$3.25 billion, 66.2 Mt, valued at \$1.75 billion, was exported primarily through the Richards Bay Coal Terminal (RBCT). Export destinations for South African coal were Europe, Asia and the Middle East, Africa, and South America. The RBCT was undertaking a major investment program to progressively increase the port coal export capacity to 81 Mt/yr by 2010. In addition, Portnet began a feasibility study to examine the potential development of a new 12-Mt/yr coal export facility at South Dunes Coal Terminal. In 1998, 162.8 Mt were consumed domestically. Domestic sales went to electricity (89.72 Mt), industry (35.45 Mt), synthetic fuels (27.69 Mt), metallurgy (5.82 Mt), and traders and households (4.11 Mt) (Department of Minerals and Energy, 1999, p. 15). Almost 90% of South Africa's electricity was generated from coal and about 6% from uranium. Three companies—Ingwe Coal Corp. Ltd., Amcoal, and Sasol Mining (Pty.) Ltd.—continued to account for more than 80% of the country's coal production. Other producers included Lonmin plc (formerly Lonrho plc) and Iscor, which mined coal for its own internal use. In addition, numerous medium-to-small, independent coal companies mined coal. Approximately 55% of all coal mined in South Africa was through underground operations. South Africa's coal reserves were mainly bituminous with relatively high ash content (about 45%) and low sulfur content (about 1%). Three fields—Waterberg, Witbank, and Highveld—hold 70% of total recoverable reserves. Several areas, including parts of the Waterberg Field, were identified as having potential for future coal bed methane development (U.S. Energy Information Administration, 2000, Country analysis briefs—South Africa, accessed February 17, 2000, at URL <http://www.eia.doe.gov/emeu/cabs/safrica.html>). The estimates of recoverable coal reserves of 55.3 billion tons were last calculated in 1987. During 1998, the DME began a new evaluation of coal resources and reserves to be based on guidelines from the United Nations Economic Commission for Europe Standards and Proposals. The new evaluation will also include an assessment of the recovery of usable energy from coal discard dumps. In 1998 alone, 62 Mt of discard coal was generated.

Petroleum and Natural Gas.—Soekor E and P (Pty.) Ltd., a subsidiary of Soekor, controlled all offshore oil and gas prospects. Crude oil production from the Oribi Field, South Africa's first offshore oilfield, which was commissioned in 1997, was nearly 6 million barrels in 1998. The Oribi Field, owned by Soekor E and P (80%) and Energy Africa (20%), was expected to produce at a rate of 20,000 barrels per day (bbl/d) of crude petroleum in 1999, providing for 6% of South Africa's daily oil requirements. This project is expected to save South Africa about \$166 million in oil import substitution during the 4-year life of the well (Mbendi Information Services, January 11, 2000, Soekor—Nature of business, accessed February 10, 2000, at URL <http://mbendi.co.za/soekor/index.htm>). South Africa's total throughput refining capacity for crude oil was 465,000 bbl/d from four refineries.

Mossgas, which uses natural gas to produce synthetic motor fuel at its plant at Mossel Bay, produced natural gas from several offshore fields. Main production was from the FA Field, which was discovered in 1984 and is situated 85 km south of the town of Mossel Bay. Two nearby satellite fields, FAH and FAR, which are situated 16 km and 8 km, respectively, northwest of the FA platform, were brought into production in May 1997. The EM gasfield, 49 km west of FA, and the smaller EBF Field were scheduled for commissioning in 2000 because the FA reserves will be depleted in 2001. These fields will provide Mossgas with gas until 2006. Mossgas was also doing additional drilling to outline newly discovered reserves of oil in the Bredasdorp Basin (Mossgas, 1999, About Mossgas, accessed December 28, 1999, at URL <http://www.mossgas.com/about.htm>).

Synthetic Fuels.—As summarized by the U.S. Energy Information Administration, South Africa had a highly developed synthetic fuels industry that took advantage of the country's abundant coal resources and offshore natural gas and condensate in Mossel Bay. The two major players were Sasol (coal-to-oil/chemicals) and Mossgas (natural-gas-to-petroleum products). Sasol had the capacity to produce 150,000 bbl/d, and Mossgas, 45,000 bbl/d. The Government decided to end Sasol's annual subsidy of about \$200 million in stages finally ending in July 1999; the subsidy was to protect it against cheaper imported crude oil.

Sasol was the world's largest manufacturer of oil from coal, with coal liquefaction plants located at Secunda (oil) and Sasolburg (petrochemicals). Started by the Government in the 1950's to help reduce South Africa's dependence on imported oil, the company was privatized in 1979. In the coal liquefaction plants, coal is first gasified, then turned into a range of liquid fuels and petrochemical feedstocks. Sasol was investing \$143 million to upgrade its Secunda facilities to reduce costs and to help it remain competitive. The project will improve the efficiency of gas to liquids conversion and reduce operating and maintenance costs. Seven new units were scheduled to be operational by the end of 1999. Sasol was also expanding its coal-to-chemical operations. Two new gas-separation plants were scheduled to be built at Secunda with the first coming online in 1999. The second unit was tentatively expected to be operational in 2001 (U.S. Energy Information Administration, 2000, Country analysis briefs—South Africa,

accessed February 17, 2000, at URL <http://www.eia.doe.gov/emeu/cabs/safrica.html>).

Reserves

South Africa's mineral reserves are large and varied and reflect the country's complex geology. A detailed description of the geology and mineral resources of South Africa was updated by the Council for Geosciences in 1998 (Wilson and Anhaeusser, 1998, 740 p.). The bulk of South Africa's mineral production is from the northern half of the country. Table 3 lists the reserve base for a number of South Africa's major minerals; diamond reserve data are unavailable. Although data for many of the minerals listed are incomplete for the world, South Africa's reserves appear to rank among the top five countries and would rank first in the world for andalusite, chromite, gold, manganese, PGM, and vanadium.

Infrastructure

The country had a well-developed and extensive road and railroad infrastructure serving not only South Africa, but also the surrounding region. Roadways totaled 331,265 km, of which 137,475 km was paved. Railroad infrastructure totaled 21,431 km, of which 9,087 km was electrified. Portnet maintained the largest and most efficient commodity export harbors in Sub-Saharan Africa, most of which handled minerals, notably Cape Town, Durban, East London, Mossel Bay, Port Elizabeth, Richards Bay, and Saldanha Bay. In addition to fulfilling the requirements of South Africa itself, the country's ports also served as outlets for such landlocked countries as Botswana, Lesotho, Swaziland, Zambia, and Zimbabwe. South Africa was also a regional supplier of electricity and petroleum products, two of a number of examples of the dependence of neighboring countries on South Africa's infrastructure and transportation networks. Richards Bay handled more than half the volume of cargo among South African ports. The RBCT had a coal export capacity of about 60 Mt/yr out of a total bulk cargo port capacity of 75 Mt/yr. A second coal export facility was being built at South Dunes near Richards Bay to handle an additional 12 Mt/yr of coal exports. Coal exports through Durban and the Mozambican port of Maputo were only a fraction of those through the RBCT. Durban's port facilities were designed mainly for small consignments of high-quality lump bituminous coal and anthracite that cannot be properly handled at Richards Bay.

Eskom had a nominal capacity of 39,872 megawatts, predominantly from coal-fired sources, with a small percentage of electricity being generated from nuclear sources (Eskom, 1999, Key statistics, Eskom annual report for 1998, accessed March 30, 1999, at URL <http://www.eskom.co.za/annreport/key.htm>). South Africa also maintained 931 km of pipeline for the distribution of crude oil, 1,748 km for petroleum products, and 322 km for natural gas.

Outlook

Significant labor issues within the minerals sector, such as housing of migrant workers, wage parity, worker health and safety, and job training, will likely continue for the next several

years. The high incidence of HIV/AIDS in South Africa also poses a threat to the workforce and economic development. Additionally, the ongoing corporate restructuring in South Africa and concomitant mine closures could further stimulate job losses in the mining industry, particularly the gold sector. Wildcat strikes and other labor disturbances were ongoing in 1998 and were continuing into 1999.

Increased attention was expected to be given to environmental issues, which also would be factors in projects requiring financing from international lending institutions. The major mining companies will likely continue to increase their holdings and activities overseas, including the forming of strategic alliances with major overseas customers. The extent to which this will contribute to new investment in South African mining is uncertain, although the large and high-quality resource base should remain attractive to new foreign investors, provided that the political risk climate remains stable.

South Africa was expanding its value-added mineral-processing capacity, especially for refined metals and alloys, during the late 1990's, with room for significantly more growth and investment in this direction. For example, in steel, the country's ready access to domestic sources of nearly all the steelmaking raw materials gave it a natural competitive advantage in this industry, offset partially by its long distances to world markets. In this regard, if labor and energy costs remained low and world markets remained buoyant, then South Africa had the potential to increase greatly its market share for many mineral commodities.

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Major Sources of Information

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P.O. Box 61809

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Fax: (27) (11) 834-1884

Internet site: <http://www.bullion.org.za>

Council for Geosciences (Geological Survey)

Private Bag X112

0001 Pretoria, South Africa

Telephone: (27) (12) 841-1911

Fax: (27) (12) 841-1203 or 1221

Internet site: <http://www.geoscience.org.za>

Department of Minerals and Energy

DRC Synodal Centre

234 Visagie St.

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0001 Pretoria, South Africa

Telephone: (27) (12) 317-9000

Fax: (27) (12) 322-4954

Internet site: <http://www.dme.gov.za>

Mine Health and Safety Inspectorate

Telephone: (27) (12) 317-9127

Fax: (27) (12) 320-2105

Internet site: <http://www.dme.gov.za/mhs/default.htm>

Mineral Development Branch

Mineral Economics Directorate (Minerals Bureau)

Telephone: (27) (12) 317-9000

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Internet site: <http://www.dme.gov.za/minerals/default.htm>

Energy Branch

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Internet site: <http://www.dme.gov.za/energy/default.htm>

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Internet: <http://www.anc.org.za/num>

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Chamber of Mines of South Africa:

Annual Report.

Statistical Tables 1997, and 1998.

Department of Mineral and Energy Affairs:

Annual Report.

Minerals Bureau:

South Africa's mineral industry 1997-98.

Operating mines and quarries and mineral processing plants in the Republic of South Africa: various periodic directories.

Mineral Production and Sales Statistics, monthly.

TABLE 1
SOUTH AFRICA: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997	1998
METALS					
Aluminum metal, primary	172,111	195,292	569,600 r/	673,043	692,500
Antimony concentrate: 2/					
Gross weight e/	7,800	9,550	8,860	5,888	7,316
Sb content	4,534	5,537	5,137	3,415	4,243
Chromite, gross weight:					
More than 48% chromic oxide thousand tons	--	16	--	--	--
44% to 48% chromic oxide do.	1,612	1,792	1,862	2,123	2,329
Less than 44% chromic oxide do.	2,030	3,296	3,155	3,617	4,151
Total do.	3,642	5,104	5,017	5,740	6,480
Cobalt:					
Mine output, Co content	358	288	350	465 e/	435 e/
Refinery output	258	190	247	318	296
Copper:					
Mine (company output), Cu content	165,213	165,573	152,595	153,058	166,000
Metal:					
Smelter	154,700	151,200	148,400 r/	163,600	160,000
Refined, primary	129,600	124,300	116,000	130,200	125,600
Gold, primary kilograms	580,201	523,809	496,846 r/	491,680	464,216
Iron and steel:					
Ore and concentrate:					
Gross weight thousand tons	30,489	31,946	30,830	33,225	32,965
Fe content do.	18,903	19,806	19,115	20,600 e/	20,438
Metal:					
Pig iron do.	6,982 r/	7,137 r/	6,876 r/	6,192	5,650
Direct-reduced iron do.	980	950	900 r/	1,090 e/	1,000 e/
Ferroalloys, electric arc furnace:					
Chromium ferroalloys do.	1,104	1,341	1,478 r/	1,940	2,025
Ferromanganese do.	591	480	562 r/	525 e/	544
Ferrosilicon do.	120	90	118 r/	102	108
Ferrovanadium e/ do.	1	1	1	5	6
Silicomanganese e/ do.	290 3/	280	241	300	307
Silicon metal do.	36	30	29 r/	34	33
Crude steel do.	8,525 r/	8,741 r/	7,999 r/	8,311	7,506
Lead:					
Concentrate, Pb content	95,824	88,449	88,613	83,114	84,128
Smelter, secondary	31,900	32,100	32,200 r/	41,500	39,200
Manganese:					
Ore and concentrate, gross weight:					
Metallurgical:					
More than 48% manganese thousand tons	1,533	1,708	1,845	1,809	1,734
45% to 48% manganese do.	67	106	86	84	12
40% to 45% manganese do.	196	191	118	116	218
30% to 40% manganese do.	1,006	1,145	1,133	1,111	1,049
Total, metallurgical 4/ do.	2,801	3,151	3,182	3,120	3,013
Chemical, 35% to 65% manganese dioxide do.	50	48	58	33	31
Grand total do.	2,851	3,199	3,240	3,153	3,044
Metal, electrolytic e/ do.	35	35	39 r/	40	40 e/
Nickel:					
Mine output, concentrate, nickel content e/	31,800	30,700	33,861 r/ 3/	34,830 3/	36,700
Metal, electrolytic	30,751	29,803	33,362	33,700	35,200 e/
Platinum-group metals: e/					
Platinum kilograms	98,285	102,300	105,440	115,861	116,483
Palladium do.	46,655	51,000	52,560	55,675	56,608
Rhodium do.	10,264	10,900	11,200	11,664	11,633
Other 5/ do.	28,722	18,897	19,436	13,266	15,419 e/
Total do.	183,926 3/	183,097 r/ 3/	188,636 r/ 3/	196,466 3/	200,143
Silver do.	197,767	174,279	168,689 r/	144,004	144,482
Thorium, monazite concentrate, gross weight e/	131 3/	--	--	--	--

See footnotes at end of table.

TABLE 1--Continued
SOUTH AFRICA: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997	1998
METALS--Continued					
Titanium: e/					
Ilmenite concentrate thousand tons	1,314	1,680	2,100	2,237	2,190 e/
Rutile concentrate do.	78	90	115 r/	123	240 e/
Total, titanium minerals do.	1,392	1,770	2,215	2,360 3/	2,430
Titaniferous slag 6/ do.	819	990	1,000 e/	1,090	1,043
Uranium oxide	2,069	1,702	1,706	1,324	1,138
Vanadium, vanadium metal content	16,350 r/	16,297 r/	14,770 r/	15,590	18,868
Zinc:					
Concentrate:					
Gross weight e/	140,000	130,000	142,000	132,000	129,000 e/
Zn content	76,361	70,241	76,853	71,062	69,630
Metal, smelter, primary	93,850	98,782	101,100	108,500	107,400
Zirconium concentrate (baddeleyite and zircon) e/	240,000	260,000	260,000	265,000 3/	265,000
INDUSTRIAL MINERALS					
Aluminosilicates:					
Andalusite	206,291	206,378	233,728 r/	251,203	236,200
Sillimanite	525	317	-- r/	--	65
Asbestos:					
Chrysotile	85,857	81,246	51,776	49,754	27,195
Crocidolite	6,273	7,396	5,344	232	--
Total	92,130	88,642	57,120	49,986	27,195
Barite	1,945	6,048	7,428	2,071	610
Calcite	14,660	10,666	13,749 r/	2,886	2,764
Cement, hydraulic thousand tons	7,905	9,071	9,580	9,980	9,000 e/
Clays:					
Attapulgit	10,230	8,049	14,318	9,349	7,671
Bentonite	71,773	70,927	48,076	33,326	48,382
Fire clay	110,131	74,751	101,452	131,307	180,885
Flint clay, raw and calcined	131,590	118,688	113,645	92,397	82,787
Kaolin	131,863	146,587	150,600 r/	122,800 r/	101,300
Brick clay, local sales thousand tons	1,386	2,909	2,919 r/	3,615 r/	3,171
Diamond, natural:					
Gem e/ thousand carats	4,900	4,300	4,400	4,500	4,700 e/
Industrial e/ do.	5,954	5,383	5,546	5,541	6,056 e/
Total 4/ do.	10,854	9,683	9,947 r/	10,041	10,756
Feldspar	37,156	47,874	53,644 r/	59,688	56,761
Fluorspar:					
Acid-grade	166,761	177,000	202,018 r/	201,000	222,000
Ceramic-grade e/	--	--	--	4,000	--
Metallurgical-grade	7,497 3/	18,794 3/	10,000 r/	2,000	15,000
Total	174,258	195,794	202,018 r/	207,000	237,000
Gemstones, semiprecious Tiger's eye kilograms	531,418	242,607 r/	18,650 r/	64,300	87,200
Gypsum, crude	304,337	288,178	340,688	365,279	485,749
Industrial or glass sand (silica) thousand tons	1,920	2,180	2,168 r/	2,439	2,273
Lime 7/ do.	2,891	1,688	1,650	1,585	1,523
Magnesite, crude	71,726	84,639	71,358	76,699	74,300
Mica, scrap and ground	1,973	2,137	1,515	1,423	1,556
Nitrogen, N content of ammonia	754,000	758,500	769,800	752,400 r/	722,800
Perlite	914	1,338	1,300	403	400 e/
Phosphate rock:					
Gross weight thousand tons	2,545	2,787	3,077	2,732	2,739
Phosphorus pentoxide content e/ do.	995	1,087	1,200	1,038	977

See footnotes at end of table.

TABLE 1--Continued
SOUTH AFRICA: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997	1998
INDUSTRIAL MINERALS--Continued					
Pigments, mineral, natural:					
Ochers	1,789	2,316	484	186	122
Oxides	295	2,940	159	98	64
Total	2,084	5,256	643	284	186
Salt	414,463	311,388	253,403	320,000	356,059
Sodium sulfate, natural	44,544	43,971	46,947	49,071	48,613
Stone, n.e.s.:					
Dimension:					
Granite and norite 7/	618,781	718,100 r/	708,700 r/	804,300	669,363
Marble 8/	5,268	1,307	2,570	--	--
Slate 7/	21,900 r/	23,500 r/	37,800 r/	11,000	23,547
Crushed and broken:					
Limestone and dolomite thousand tons	19,548	19,738	22,038	22,214	19,754
Nepheline syenite	98,667	145,459	137,706 r/	114,201	11,500 e/
Quartzite 6/ thousand tons	9,258	9,123	8,515	8,500	10,203
Shale:					
For cement do.	371	325	338 r/	334	280
Other 6/ do.	2,157	3,248	3,000 e/	3,000 e/	3,707 e/
Total do.	2,528	3,573	3,338	3,334	3,986
Aggregate and sand, n.e.s. do.	18,294	20,594	20,792	32,950	33,980
Sulfur:					
S content of pyrite do.	252	159	160 e/	133 e/	120 e/
Byproduct:					
Metallurgy e/ do.	118	117	80 e/	86 e/	93 e/
Petroleum do.	209	233	195 e/	230 e/	223 e/
Total 4/ do.	579	509	435	449	436
Talc and related materials:					
Talc	8,202	9,173	16,397	24,400	21,900
Pyrophyllite (wonderstone)	5,507	5,519	2,140	2,129	2,532
Vermiculite	223,478	221,748	184,300 r/	212,000	229,300 e/
MINERAL FUELS AND RELATED MATERIALS					
Coal (salable product):					
Anthracite thousand tons	2,225	2,137	2,465 r/	1,997	2,101
Bituminous do.	193,625	204,073	203,803 r/	216,453	222,283
Total 4/ do.	195,850	206,210	206,269 r/	218,450	224,385
Natural gas million cubic meters	1,980	1,980	980	1,756	1,560 e/
Petroleum: 9/	--	--	--		
Crude thousand 42-gallon barrels	--	--	--	3,744	6,549 e/
Refinery products:					
Liquefied petroleum gases do.	1,825	3,285	3,285 r/	3,000 e/	3,000 e/
Gasoline do.	59,860	73,730	66,795 r/	67,000 e/	67,000 e/
Jet fuel do.	7,665	8,760	10,220 r/	10,000 e/	10,000 e/
Kerosene do.	5,475	7,300	6,935 r/	7,000 e/	7,000 e/
Distillate fuel oil do.	35,770	50,005	49,275 r/	50,000 e/	50,000 e/
Residual fuel oil e/ do.	20,075 3/	22,995 3/	25,550 r/	25,000 e/	25,000 e/
Lubricants (including greases) e/ do.	1,280 3/	3,000	3,000 e/	3,000 e/	3,000 e/
Bitumen e/ do.	895 3/	2,000	2,000 e/	2,000 e/	2,000 e/
Other e/ do.	380 3/	4,855	5,950 r/	6,000 e/	6,000 e/
Total 10/ do.	133,225	175,930	173,010 r/	173,000 e/	173,000 e/

e/ Estimated. r/ Revised.

1/ Table includes data available through December 1999.

2/ Data are for the year ending June 30 of that stated.

3/ Reported figure.

4/ Data may not add to totals shown because of independent rounding.

5/ Difference between total production reported by the Minerals Bureau and platinum, palladium, and rhodium supplies (shipments) reported in Johnson and Matthey Annual Platinum Review. Includes ruthenium and iridium production plus excess platinum, palladium, or rhodium inventory.

6/ Except for about 45,000 metric tons per year of slag derived from titaniferous magnetite by Highveld Steel and Vanadium Corp. Ltd., titaniferous slag is all from the smelting of ilmenite and likely represents most of that mineral's production, for which complete data are unavailable.

7/ Domestic sales plus exports.

8/ Converted from reported cubic meters using 1 cubic meter = 2.7 metric tons.

9/ In addition, Sasol produces about 67 million barrels per year of synthetic liquid petroleum fuels from coal.

10/ Excludes refinery fuel and losses.

TABLE 2
SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY 1/

(Thousand metric tons unless otherwise specified)

Major commodities	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Aluminum	Billiton Aluminium South Africa (Pty.) Ltd. (Billiton plc, 100%)	Bayside smelter at Richards Bay	175.
Do.	do.	Hillside smelter at Richards Bay	500+.
Andalusite	Rhino Minerals (Pty.) Ltd. (Mircal South Africa (Pty.) Ltd., 100%, acquired from Avmin July 1999)	Rhino Mine near Thabazimbi	120.
Do.	do.	Havercroft Mine at Penge, N. of Steelpoort	60.
Do.	Samrec Pty. Ltd. of France (private, 100%)	Annesley Mine at Penge, 50 kilometers north of Steelpoort	75.
Do.	do.	Andalusite Refractories Mine at Groot Marico 60 kilometers west of Rustenburg	12.
Do.	do.	Krugerpost Mine, near Lydenburg	50.
Do.	Hoogenoeg Andalusite (Pty.) Ltd.	Hoogenoeg Mine, 60 kilometers northeast of Potgietersrus	15.
Antimony	Consolidated Murchison Ltd. [Metorex Pty. Ltd., 34.3%; Crew Development Corp. (Canada), 3.3%]	50 kilometers west of Phalaborwa	7 Sb concentrate, 1,000 kg gold byproduct.
Asbestos	Kaapsehoop Asbestos Pty. Ltd.	New Amianthus Mine in Mpumalanga	NA (chrysotile).
Do.	African Chrysotile Asbestos Ltd.	Msauli Mine near Barberton	NA (chrysotile).
Do.	Anglo Dutch Exploration & Mining Co. (Pty.) Ltd.	Stella Mine, 25 kilometers east of Barberton	NA (chrysotile).
Do.	Griqualand Exploration and Finance Corp.	Kuruman Mine (closed in 1998)	NA (crocidolite).
Cement	Anglo Alpha Ltd. (Holderbank; Anglovaal Industries Ltd.)	Dudfield kiln near Lichtenburg, also grinding mill at Roodepoort	1,830.
Do.	do.	Ulco kiln 60 kilometers northwest of Kimberley	1,615.
Do.	Lafarge South Africa Ltd. [Lafarge (France)] (formerly Blue Circle Cement (Pty.) Ltd.)	Lichtenburg kiln	2,200.
Do.	do.	White's kiln	200.
Do.	Natal Portland Cement Co. (Pty.) Ltd. (co-owned by Anglo Alpha, Lafarge, and Pretoria Portland Cement companies).	Simumu plant, 125 kilometers southwest of Durban; also grinding mills at Durban and Newcastle	1,500.
Do.	Pretoria Portland Cement Co. Ltd. (Barlow Rand Group, 60.3%)	De Hoek, Dwaalboom, Herculese, Jupiter, Slurru, Riebeeck West, and Port Elizabeth kilns	5,500 (combined), clinker.
Chromite	Samancor Ltd. (Billiton plc, 60%, Anglo American plc, 40%)	Eastern Chrome Mines in Steelpoort Valley, Mpumalanga Province, includes: Lannex, Groothoek, Jagdlust, Mooihoek, Tweefontein, and Steelpoort mines	2,200 run-of-mine ore.
Do.	do.	Western Chrome Mines in Northern Province includes Elandsdrift, Mooiooi, Ruighoek, and Waterkloof-Millsell mines	1,800 run-of-mine ore.
Do.	Chromecorp Holdings Ltd. [Xstrata Ag, nec (Sudelektra Holdings AG, (Switzerland) 100%)]	Kroondal Mine east of Rustenburg	1,260 ore; 880 concentrate.
Do.	do.	Wonderkop Mine east of Rustenburg	720 ore; 400 concentrate.
Do.	do.	Chroombronne Mine, near Rustenburg	576 ore; 432 concentrate.
Do.	do.	Purity Mine, near Rustenburg	360 ore; 252 concentrate.
Do.	Hernic Ferrochrome Pty. Ltd., [E.L. Haniel (Germany); Nittetsu Shoji (Japan)]	Hernic Chrome Mine	NA.
Do.	Bayer Pty. Ltd.	Rustenburg Chrome Mine	NA.
Do.	Lavino South Africa (Pty.) Ltd. (Anglovaal Minerals Ltd., 51%; Middle Witwatersrand, 49%)	Grootboom Mine, near Lydenburg	500 ore.
Do.	Dilokong Chrome Mine (Pty.) Ltd. (Mining Corp. Ltd., 100%)	Dilokong Mine, near Lydenburg	480 ore.
Do.	Associated Manganese Mines of South Africa Ltd. (Anglovaal Minerals Ltd., 50.2%; Associated Ore & Metal Corp., 45.2%)	Dwarsrivier Mine to open 2000	1,000 run-of-mine ore.
Coal	Amcoal Colliery and Industrial Operations Ltd. (Anglo American Plc., 52%)	8 collieries: Arnot, Bank, Goedeheop, Kriel, New Denmark, New Vaal, SA Coal Estates, and Vryheid Coronation, in Mpumalanga and KwaZulu-Natal	52,000 anthracite and bituminous.
Do.	Ingwe Coal Corp. Ltd. (Billiton Plc., 100%)	10 collieries in Mpumalanga and KwaZulu-Natal Provinces	59,000 anthracite and bituminous.
Do.	Duiker Mining Ltd. (Lonmin Plc., 68%)	Duiker and Tavistock collieries (6 mines, includes Tweefontein and Spitzkop collieries)	20,000.
Do.	Duvha Opencast Services (Pty.) Ltd. (Rand Mines Ltd., 71%)	Duvha Colliery, 18 kilometers southeast of Witbank	11,000 bituminous.
Do.	Kangra Group Pty. Ltd.	Savamore, Springlake, Taaboschpruit, and Welgedacht collieries	4,300 bituminous and steam.

See footnotes at end of table.

TABLE 2--Continued
SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY 1/

(Thousand metric tons unless otherwise specified)

Major commodities	Major operating companies and major equity owners		Location of main facilities	Annual capacity
Coal	Sasol Mining (Pty.) Ltd. (Sasol, 100%)		Sigma Colliery, 2 mines, 75 kilometers south of Johannesburg (closing end 1999)	5,500 bituminous.
Do.	do.		Secunda Collieries, 6 mines, 75 kilometers south of Witbank	43,000 bituminous.
Do.	Isacor Mining (Isacor Ltd., 100%)		Grootegeluk Mine, 120 kilometers north of Thabazimbi	12,000 steam coal, 2,000 coking coal, 450 metallurgical coal.
Do.	do.		Leeuwpans Colliery in Mpumalanga Province	1,250 steam coal.
Do.	do.		Durnacol Mine at Dannhauser, 40 kilometers south of Newcastle	530 coking coal.
Do.	do.		Tshikondeni Mine in Venda, about 100 kilometers southeast of Messina	410 coking coal.
Do.	Anglovaal Minerals Ltd. (100%)		Dortfontein Colliery	700.
Do.	do.		Forzando Colliery	1,350.
Do.	New Coal (Amcoal/Ingwe empowerment vehicle)		Matla, Arnot underground, Glisa, and, New Clydesdale collieries	NA.
Do.	Kuyasa Mining (Pty.) Ltd.		Ikhezezi mine, near Delmas	350.
Do.	Gold Fields Coal Ltd		Greenside and New Clydesdale collieries	3,000.
Do.	Anker Holdings B.V. (Netherlands)		Elandsfontein, Golfview, Van Oudshoornstrom, and Woestalleen collieries	5,000. e/
Do.	Wakefield Coal Division, [Metorex Pty. Ltd., 40.07% (Canada)]		Leeuwpans and Side collieries in Witbank Coalfield	1,300 steam.
Copper	Palabora Mining Co. Ltd. (Rio Tinto Ltd., 46.4%, Anglo American plc /De Beers, 29%)		Palabora open pit mine and plant at Phalaborwa (Switch to underground mining in 2002)	130 metal, then reduces to 75 metal.
Do.	do.		Copper smelter at Phalaborwa	140 anodes.
Do.	do.		Copper refinery at Phalaborwa	125 cathodes
Do.	O'okiep Copper Co. Ltd. [Metorex (Pty.) Limited, 89%]		Nigramoep copper mine, near Nababeep, Northern Cape Province	15 Cu in concentrates.
Do.	do.		O'okiep copper smelter at Nababeep	42 blister.
Do.	Black Mountain Mineral Development Co. (Pty.) Ltd. (Anglo American plc., 100%)		Black Mountain Mine near Aggeneys, 100 kilometers northeast of O'okiep	5 Cu in concentrate.
Do.	Maranda Mining Co. [Metorex (Pty.) Limited, 29.1%]		Maranda zinc-copper mine in Murchison Range in Northern province	1.6 Cu metal.
Diamond	thousand carats	De Beers Consolidated Mines Ltd., (Anglo American plc, 29%)	Finsch Mine, 100 kilometers west of Kimberley	2,500. e/
Do.	do.	do.	Kimberley Mines, Kimberley	800. e/
Do.	do.	do.	Koffiefontein Mine, 70 kilometers south of Kimberley	200. e/
Do.	do.	do.	Namaqualand Mines, 50 kilometers north of Port Nolloth	800. e/
Do.	do.	do.	Premier Mine, 70 kilometers east of Pretoria	1,700. e/
Do.	do.	De Beers, 50%; Saturn Partnership, 50%, (of which Avmin, 87.5%, Industrial & Commercial Holding group, 12.5%)	Venetia Mine, 150 kilometers north of Potgietersrus	5,000. e/
Do.	do.	SouthernEra Resources Ltd (Canada), (In joint venture with De Beers or Randgold Resources on some operations	Klipspringer project, includes 10 kimberlite fissures and pipes near Potgietersrus in Northern Province	1,000.
Do.	do.	Benguela Concessions Ltd.	Several marine operations along Namaqualand coast; Moonstone mining ship	40.
Do.	do.	Trans Hex Group Ltd.	Baken deposit on Orange River; So Ver, Reuning, Komagass, and Hondklip Bay mines, and 3 marine operations off Northern Province	200.
Fluorspar	Vergenoeg Mining Corp. (Pty.) Ltd. [Metorex Pty. Ltd., 70%; Minerale y Productos Derivados SA (Spain), 30%]		Vergenoeg Mine, 90 kilometers east of Pretoria	100 acid grade fluorspar, 10 metallurgical grade fluorspar.
Do.	South Africa Land & Exploration Co., [Athlone International (Australia), 100%]		Witkop Mine, 130 kilometers west of Johannesburg	100 acid-grade fluorspar (plan to double capacity).
Do.	Van den Heever Fluorspar Works		Van Den Heever Mine, 120 kilometers west of Johannesburg	50 e/ metallurgical grade fluorspar.

See footnotes at end of table.

TABLE 2--Continued
SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY 1/

(Thousand metric tons unless otherwise specified)

Major commodities	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Gold	AngloGold Ltd.	13 mines southwest of Johannesburg: Great Noligwa (ex-Vaal Reefs Shaft 8), Kopanang (Vaal Reefs #9), Tau Lekoa (Vaal Reefs #10), Moab Khotson (Vaal Reefs #11), Bamabanani (Freegold #1), Tsepong (Freegold #2), Majhabeng (ex-Western Holdings), H.J. Joel, Western Deeps-East, Western Deeps-West, Western Deeps-South, Deelkraal, and Elandsrand, plus Western Ultra Deep Levels project	186 Au. South African operations only.
Do.	Gold Fields Ltd.	Beatrix, Driefontein, Kloof, Leeudoom, Oryx, Libanon, St.Helena, and Target mines; west and southwest of Johannesburg	125 Au. South African operations only.
Do.	Harmony Gold Mining Co. Ltd.	Harmony, Evander, Masimong (ex-Freegold #3) and Brand mines, in Free State area	49 Au.
Do.	Avgold Ltd. (Anglovaal Mining Ltd., 60.1%)	Eastern Transvaal Consolidated, and Loraine mines near Klerksdorp, plus Target and Sun developments	20 Au.
Do.	do.		
Do.	Durban Roodeport Deep Ltd.	Blyvoornuitzicht, Buffelsfontein, Crown, Durban Deep and West Wits Sections; Hartebeestfontein Mine plus Argonaut Project	20 Au in 1999, 37 Au in 2000.
Do.	Randfontein Estates Ltd. (JCI Gold, 100%) (JCI Gold, 100%)	Cooke 1, 2 and 3 Shafts, Doornkop, Lindum and Western Areas North Shaft near Randfontein, Doornkop South Reef development	26 Au.
Do.	Western Areas Ltd. (JCI Gold, 50%, and Placer Dome Inc., 50%)	Western Areas and South Deep	12 Au.
Do.	Kalahari Goldridge Mining Co. Ltd.	Kalgold Mine near Kraaipan	3.2 Au.
Do.	Rand Refinery Ltd.	Gold Refinery, Germiston, Gauteng Province	1,200 refined Au.
Iron and steel:			
Iron ore	Isacor Ltd.	Sishen Mine at Sishen	27,000 ore, to 32,000 by 2002.
Do.	do.	Thabazimbi Mine at Thabazimbi	2,900 ore.
Do.	Highveld Steel and Vanadium Corp. Ltd. (Anglo American Industrial Corp. Ltd., 51.8%)	Mapochs Mine at Roosenekal, 60 kilometers west of Lydenburg	3,000 titaniferous and vanadiferous magnetite ore.
Do.	Associated Manganese Mines of South Africa Ltd. (Anglovaal Minerals Ltd., 50.2%)	Beeshoek Mine near Postmasburg	4,500 ore.
Ferroalloys 2/	Samancor Chrome Division (Billiton plc., 54.6%, Anglo American plc, 28.9% , other private, 16.5%)	Ferrometals plant at Witbank (6 furnaces) (2 furnaces, 110,000 capacity closing in 1999)	450 ferrochromium.
Do.	do.	Tubatse Ferrochrome plant at Steelpoort (6 furnaces)	340 ferrochromium.
Do.	do.	Middelburg Ferrochrome plant 35 kilometers east of Witbank, (3 furnaces)	235 ferrochromium.
Do.	do.	Palmiet Ferrochrome plant at Krugersdorp, 30 kilometers west of Johannesburg, (3 furnaces)	120 ferrochromium.
Do.	do.	Bathlako Ferrochrome plant at Ruighoek, northwest of Rustenburg	20 ferrochromium.
Do.	Chromecorp Holdings Ltd., [Xstrata AG, formerly Sudelektra Holding AG (Switzerland), 100%]	Rustenburg (6 furnaces)	400 ferrochromium.
Do.	do.	Lydenburg (4 furnaces)	350 ferrochromium.
Do.	do.	Wonderkop (4 furnaces)	320 ferrochromium.
Do.	do.	Rustenburg slag retreatment plant	25 ferrochromium.
Do.	do.	Wonderkop slag retreatment plant	20 ferrochromium.
Do.	do.	Silicon Technology plant at Ballengeich, KZN	55 ferrosilicon.
Do.	Hernic Ferrochrome Pty. Ltd., [ELG Haniel (Germany); Nittetsu Shoji (Japan)]	Plant near Brits, (2 furnaces). expanding to 260,000 metric tons by 2000	135 ferrochromium.
Do.	Feralloys Ltd. (Associated Manganese Mines of South Africa Ltd., 100%)	Machadodorp plant, (3 furnaces), 80 kilometers east of Middelburg	150 ferrochromium, 175 by 2000.
Do.	do.	Cato Ridge, 75 kilometers west of Durban	245 high-carbon ferromanganese.
Do.	Samancor Manganese Division, (Billiton plc., 54.6%, Anglo American plc, 28.9% , other private, 16.5%)	Meyerton plant, (10 furnaces), 50 kilometers south of Johannesburg; can switch between FeMn and SiMn	532 high-carbon ferromanganese, 200 silicomanganese.
Do.	Manganese Metal Co. (Pty.) Ltd. (Samancor Ltd.)	Plants at Krugersdorp and Nelspruit	44 electrolytic manganese.
Do.	Transalloys Division (Highveld Steel and Vanadium Corp. Ltd., 100%)	Witbank	50 medium-carbon ferromanganese, 175 silicomanganese.
Do.	ASA Metals Pty. Ltd. (Eastern Asia Metal Investment Co. Ltd., 60%; Northern Province Development Corp., 40%)	Plant near Pietersburg, Northern Province (associated with Dilokong Chrome)	50 ferrochrome.

See footnotes at end of table.

TABLE 2--Continued
SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY 1/

(Thousand metric tons unless otherwise specified)

Major commodities	Major operating companies and major equity owners		Location of main facilities	Annual capacity
Ferroalloys 2/--Continued	Rand Carbide Division, Highveld Steel and Vanadium Corp. Ltd. (100%)		Plant at Witbank, Mpumalanga Province	58 ferrosilicon.
Do.	tons	Vametco Minerals Corp. (Startegic Minerals Corp., USA, 100%)	Smelter near Brits	5,250 ferrovanadium.
Steel		Isacor Ltd.	Vanderbijlpark Works	3,200 flat products.
Do.		do.	Newcastle Works	2,000 profile products.
Do.		do.	Vereeniging Works	450 e/ specialty steels.
Do.		Highveld Steel and Vanadium Corp. Ltd. (Anglo American Industrial Corp. Ltd., 51.8%; De Beers, 3.8%)	Witbank	1,000.
Do.		Columbus Stainless Steel Ltd. (Samancor, 33.3%; Highveld Steel and Vanadium Corp. Ltd., 33.3%; Industrial Development Corp. (IDC), 33.3%)	Stainless steel plant at Middelburg	500.
Do.		Saldanha Steel (Pty.) Ltd. (Isacor Ltd., 50%, IDC, 50%)	Hot-rolled steel coil plant at Saldanha Bay	1,200.
Do.		Davsteel Division, Cape Gate Pty. Ltd.	Vanderbijlpark plant, Gauteng.	400.
Manganese		Associated Manganese Mines of South Africa Ltd. (Avmin Ltd., 50.2%)	Gloria and N'Chwaning Mines near Black Rock, 70 kilometers north of Sishen	1,500 ore.
Do.		Samancor Ltd. (Billiton plc., 60%, Anglo American plc, 40%).	Mamatwan Mine	2,200 ore.
Do.		do.	Wessels Mine, both near Hotazel	1,200 ore.
Do.		Manganese Metal Co. Pty. Ltd. (Samancor Ltd., 100%)	Electrolytic plant at Nelspruit	26 manganese metal.
Do.		do.	Electrolytic plant at Krugersdorp	18 manganese metal.
Do.		Metmin (Metorex Pty. Ltd., 100%)	Open pit mine in North West Province (Used as catalyst for extracting uranium from gold)	24 manganese dioxide.
Nickel		Nkomati Joint Venture (Anglovaal Mining Ltd., 75%; Anglo American plc., 25%)	Nkomati Mine in Mpumalanga Province	15 nickel in concentrate.
Petroleum, crude million 42-gallon barrels		Soeker (Government, 100%)	Oribi field 140 kilometers southwest offshore from Mossel Bay	9.1.
Do.	do.	do.	Oryx field in production 1999	1.8. e/
Do.	do.	Mossas (Pty.) Ltd. (Government, 100% through Central Energy Fund).	9 wells in Mossel Bay	3.5.
Do.	do.	Shell and BP Refineries Pty. Ltd. (Shell South Africa, 50%; BP Group, 50%)	Sanref refinery in Durban	60 crude.
Do.	do.	Caltex Oil SA Pty. Ltd. (private, 100%)	Refinery in Cape Town	41 crude.
Do.	do.	National Petroleum Refiners of South Africa Pty. Ltd. (Sasol Ltd., Total SA)	Natref Refinery in Secunda, 100 kilometers southeast of Johannesburg	32 crude.
Do.	do.	Engen Ltd. (62%)	Gencor Refinery in Durban	38 crude.
Phosphate		Phosphate Development Corp. Ltd. (Foskor (Foskor Ltd.) (IDC, 100%)	Foskor mine and plant at Phalaborwa	2,900 phosphate rock. 3/
Platinum-group metals kilograms		Anglo American Platinum Corp. Ltd., (Anglo American plc., 100%).	Rustenburg Section near Rustenburg, Union and Amandelbult Sections about 50 kilometers south of Thabazimbi Lebowa Platinum (Atok) Mine, 70 kilometers east of Potgietersrus; and Potgietersrust Platinum Mine near Potgietersrus	70,000 platinum metal, 34,000 palladium metal, 6,500 rhodium metal.
Do.	do.	do.	Bafokeng Rasimone mine in Northern Province opening in 2000	7,776 PGM metal.
Do.	do.	Impala Platinum Ltd. (Implats) (Impala Platinum Holdings Ltd., 100%)	13 mine shafts, concentrator, and smelter near Rustenburg, NW Province; refinery near Springs, Gauteng Province	33,000 platinum, 18,000 palladium, 4,500 rhodium.
Do.	do.	Lonmin Platinum (Lonmin Plc., 73%; Impala Platinum Holdings Ltd., 27%)	3 mines (Eastern Platinum, Karee, and Western Platinum) near Rustenburg	37,324 PGM (in concentrates).
Do.	do.	do.	Smelter and precious metals refinery, at Western Platinum, 20 kilometers east of Rustenburg	20,600 platinum, 9,330 palladium, 2,800 rhodium.
Do.	do.	Northam Platinum Ltd. (Gold Fields of South Africa, 82%)	Northam Mine 20 kilometers south of Thabazimbi	6,220 platinum.
Do.	do.	Kroondal Platinum Mines Ltd., [Aquarius Platinum Ltd., (Australia), 45%, and Implats, 15%].	Kroondal Mine, 10 kilometers east of Rustenburg; opening in 2000	3,110 platinum, 1,866 palladium, 933 other PGM.
Do.	do.	Messina Holdings Ltd. (SouthernEra Resources Ltd., 54%)	Messina platinum deposit, near Klipspringer diamond mine, Northern Province	3,730 PGM + gold, Startup in 2001.

See footnotes at end of table.

TABLE 2--Continued
SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY 1/

(Thousand metric tons unless otherwise specified)

Major commodities	Major operating companies and major equity owners		Location of main facilities	Annual capacity
Pyrophyllite	Alpha Ltd.		Idwala Industrial Minerals plant, and Witpoort Quarry	NA.
	Wonderstone Ltd. (The Associated Ore & Metals Corp. Ltd.)		Pyrophyllite (wonderstone) mine in North-West Province	NA.
Do.	G&W Base and Industrial Minerals Pty. Ltd.		Masala Mine, Mpumalanga	NA.
Silicon	Silicon Smelters (Samancor Ltd.)		Near Pietersburg, Northern Province (3 submerged arc furnaces)	40 silicon.
Synthetic fuels million 42-gallon barrels	Sasol Ltd. (Government, 100%)		Coal to oil plant at Secunda and a coal to petrochemical plant at Sasolburg	54.8.
Do. do.	Moss gas (Pty.) Ltd. (Government, 100% through Central Energy Fund).		Natural gas to petroleum products plant at Mossel Bay	16.4.
Titanium:				
Titanium concentrates	Richards Bay Minerals trading for Tisands (Pty.) Ltd. and Richards Bay Iron and Titanium (Pty.) Ltd. (Rio Tinto Plc., 50%; Billiton Plc., 50%)		Opencast operations near Richards Bay	1,280 ilmenite concentrate, e/ 125 rutile concentrate. e/
Do.	Namakwa Sands Ltd. (Anglo Operations Ltd, a subsidiary of Anglo American plc, 100%)		Opencast mine near Brand-se-Baai and mineral separation plant at Koekenaap, 300 kilometers northwest of Cape Town	540 ilmenite concentrate, 42 rutile concentrate.
Titanium slag	Richards Bay Iron and Titanium (Pty.) Ltd./ Richards Bay Minerals (Rio Tinto Plc.)		Smelter at Richards Bay	1,000 titania slag.
Do.	Namakwa Sands Ltd. [Anglo Operations Ltd (a subsidiary of Anglo American plc), 100%]		Smelter at Vredenberg, Saldanha Bay area	230 titania slag (by 2000), 120 pig iron.
Do.	Highveld Steel and Vanadium Corp. Ltd.		Steel plant at Witbank	48 titania slag. e/
Uranium tons	AngloGold Ltd. (Anglo American plc., 60%; De Beers, 40%)		Vaal Reefs Mine and plant near Klerksdorp	2,000 uranium oxide e/ (900 @=1998-99 output).
Do. do.	Avgold Ltd. (Anglovaal Minerals Ltd, 100%).		Hartebeestfontein Mine and plant, 5 kilometers southeast of Klerksdorp	400 uranium oxide e/ (<200 @=1998-99 output).
Do. do.	Palabora Mining Co. Ltd.		Palabora Mine and plant at Phalaborwa	160 uranium oxide. e/
Vanadium do.	Highveld Vanadium and Chemicals Corp. Ltd. (Anglo American Industrial Corp. through Highveld Steel and Vanadium Corp. Ltd.)		Mapochs Mine near Lydenburg	25,000 vanadium pentoxide. e/
Do. do. do.	do.		Highveld steel plant in Witbank	17,000 vanadium pentoxide.
Do. do. do.	do.		Highveld Vantra plant in Witbank	8,000 vanadium pentoxide.
Do. do.	Vametco Minerals Corp. (Strategic Minerals Corp., USA, 100%)		Krokodilkraal Mine and plant near Brits	5,000 vanadium pentoxide. e/
Do. do.	Transvaal Alloys Pty. Ltd., (Highveld Steel and Vanadium Corp., 100%)		Wapadskloof Mine and plant, 60 kilometers northeast of Middelburg	2,250 vanadium pentoxide. e/
Do. do.	Vanadium Technology Pty. Ltd. [Xstrata AG, formerly Sudelektra Holding AG (Switzerland), 100%]		Kennedy's Vale (ex-Vansa Vanadium) Mine and plant, near Lydenburg	5,900 vanadium pentoxide, 1,500 ferrovanadium.
Do. do.	Rhombus Vanadium Holdings Ltd. [Xstrata AG, formerly Sudelektra Holding AG (Switzerland), 100%]		Ba-Mogopa Mine and Usko plant	13,500 vanadium.
Vermiculite	Palabora Mining Co. Ltd.		Palabora mine and plant at Phalaborwa	230 concentrate. e/
Do.	Natkruit Vermiculite Mine Pty. Ltd., (Verimex Trading Pty. Ltd.		Mine near Soutpansberg, Northern Province	22 concentrate (closed, March 1999).
Zinc	Zinc Corp. of South Africa Ltd. (Isacor Ltd., 100%)		Struisbult Springszinc refinery at Springs, southeast of Johannesburg	120 Zn.
Do.	Black Mountain Mineral Development Co. (Pty.) Ltd. (Anglo American plc., 100%).		Black Mountain Mine near Aggeneys, 100 kilometers northeast of Okiep	26 Zn (in concentrate).
Do.	Maranda Mining Co. [Metorex (Pty.) Ltd., 29.1%]		Maranda zinc-copper mine in Murchison Range in Northern Province	15 Zn metal in concentrates.
Do.	Pering Mine (Pty) Ltd. (Billiton plc., 100%)		Pering mine in Northern Cape Province (Phased closure begun in 1999)	27 Zn in concentrate 6 Pb in concentrate
Zirconium	Tisand (Pty.) Ltd./Richards Bay Minerals Ltd.		Opencast mines near Richards Bay	300 zircon concentrate.
Do.	Namakwa Sands Ltd. [Anglo Operations Ltd. (a subsidiary of Anglo American plc), 100%]		Opencast mine near Brand-se-Baai and mineral separation plant at Koekenaap	140 zircon concentrate.
Do.	Palabora Mining Co. Ltd.		Palabora Mine and plant at Phalaborwa	14 baddeleyite. e/
Do.	do.		Zirconium basic sulfate plant at Phalaborwa	8 Zr basic sulfate (by 1999).
Do.	Phosphate Development Corp. Ltd. (Foskor Ltd) (IDC, 100%)		Plant at Phalaborwa	3 baddeleyite. e/
Do.	do.		Fused zirconia plant	6 synthetic zirconia.

e/ Estimated.

1/ Based on information available as of September 1999.

2/ Depending on markets furnace capacity can switch between FeCr and FeMn.

3/ Most of Foskor's phosphate output is from phosphate concentrates supplied by the neighboring Palabora copper mine.

TABLE 3
SOUTH AFRICA: RESERVE BASE OF MAJOR MINERALS IN 1998 1/

(Million metric tons unless otherwise specified)

Commodity	Reserve base
Andalusite 2/	50.8
Antimony thousand tons	250
Asbestos, fiber	8.2
Chromium, ore	3,100
Coal, recoverable	55,333
Cobalt 3/ thousand tons	15
Copper	13
Fluorspar	36
Gold thousand tons	40
Iron ore	5,900
Lead	3
Manganese	4,000
Natural gas million cubic meters	1,557
Nickel 3/	11.8
Petroleum million barrels	29
Phosphate rock, concentrates	2,500
Platinum-group metals thousand tons	62.8
Silver do.	10
Titanium	146
Uranium 4/ thousand tons	204.7
Vanadium	12.5
Vermiculite	80
Zinc	15
Zirconium	14.3

1/ Metallic minerals are contained metal.

2/ Includes the aluminosilicate, sillimanite.

3/ Minerals Bureau estimates as of December 31, 1997.

4/ Recoverable at a cost of less than \$80 per kilogram.

Sources: Chamber of Mines Online Statistical Tables 1997, accessible at URL <http://www.bullion.org.za/panl/genrl/sawmres.htm>. Minerals Bureau estimates as of December 31, 1998. U.S. Energy Information Administration, Country Analysis Briefs--South Africa.

THE MINERAL INDUSTRY OF

SUDAN

By Philip M. Mobbs

Mineral commodities produced in Sudan, Africa's largest country, included cement, chromite, crude construction material, gold, gypsum, limestone, crude oil, petroleum refinery products, and salt. (See table 1.) The quantities were relatively small and were a minor contribution to Sudan's economy. The 15-year-old civil war in the south adversely affected mineral exploration in the region. The political climate and continued economic instability were likely to deter major international efforts at further exploiting the remaining mineral potential of Sudan.

In 1998, LaSource Compagnie Minière continued gold exploration around the Ariab gold mine, and McVicar Minerals Ltd. of Canada acquired the Shulai gold property. Billiton Plc.

of the United Kingdom was awarded a 3-year concession for copper exploration in the Hofrat an-Nahas area. Nile Cement Co. was expanding its 100,000-metric-ton-per-year (t/yr)-capacity plant to 400,000 t/yr. Despite rebel military operations, the Greater Nile Petroleum Operating Co. drilled 29 development wells and 18 wildcat wells. Construction of the 1,500-kilometer, 71-centimeter-diameter pipeline from the Muglad Basin oilfields to Port Sudan continued during the year. Talisman Energy Inc. of Canada acquired Arakis Energy Corp. and its 25% interest in the Greater Nile Oil Project in October.

For more extensive coverage of the mineral industry of the Sudan, see the 1995 Minerals Yearbook, Volume III, Mineral Industries of Africa and the Middle East, pages 150-151.

TABLE 1
SUDAN: ESTIMATED PRODUCTION OF MINERAL COMMODITIES 1/ 2/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997	1998
Cement, hydraulic	250,000	391,000	380,000	380,000	380,000
Chromite, mine output, gross weight 3/	25,000	44,988 4/	15,000	10,000	10,000
Gold, mine output, Au content kilograms	3,000	3,700	4,500	5,000	5,000
Petroleum:					
Crude (including lease condensate) thousand 42-gallon barrels	730	730	1,000	2,000 r/	1,200
Refinery products do.	6,500	6,600	7,000	7,000	7,000
Salt	75,000	75,000	50,000	50,000	45,000

r/ Revised.

1/ Includes data available through May 20, 1999.

2/ In addition to the commodities listed, the following are presumably produced, but available information is inadequate to reliably estimate output: clay and/or shale for cement manufacture (normally about 0.4 metric ton of clay and/or shale per metric ton of finished cement); gypsum for cement manufacture (about 0.04 ton per ton of finished cement) and plaster; limestone for cement manufacture (normally at least 1.25 ton per ton of finished cement), agriculture, lime manufacture, and construction aggregate and fill; and other locally used construction materials (clays, sand and gravel, stone, et al.).

3/ Presumed to be ores and concentrates with an estimated average grade of about 48% chromic oxide.

4/ Reported figure.

THE MINERAL INDUSTRY OF SWAZILAND

By Philip M. Mobbs and George J. Coakley

Mining was a small but important factor in Swaziland's economy, accounting for about \$17.6 million,¹ or less than 2% of the kingdom's gross domestic product, which was estimated to be \$1.1 billion (Central Bank of Swaziland, Annual report—97-98, accessed November 27, 1999, at URL http://www.centralbank.sz/report98/ar98_4.html; World Bank, September 22, 1999, Swaziland at a glance, accessed November 26, 1999, at URL <http://www.worldbank.org/data/countrydata/countrydata.html>). Mining employed fewer than 1,000 workers in Swaziland; an additional 1,000 Swazis processed timber that was exported to mines in South Africa, and 10,000 to 15,000 Swazis were employed in South African mines. Wage repatriation from miners in South Africa contributed to the Swazi economy; however, the collapse of international gold prices and subsequent downsizing of the South African gold mining labor force resulted in layoffs of a number of Swazi miners.

In 1998, the Investment Promotion Bill of 1997 became law. The legislation, part of the Swazi Economic and Social Reform Agenda, was to promote local and foreign investment in Swaziland. The Swaziland Investment Promotion Authority, a proposed one-stop service center for investors, was expected to open in 1999.

Asbestos, coal, and crushed stone remained the country's main mining products. The Swazi Geological Survey and Mines Department was exploring for diamond near Hhelehhele, about 60 kilometers south of Dvokolwako. Southern Era Resources Ltd. of Canada discontinued exploration activity on the Daisy and the Piggs Peak gold licences. The Government's Mineral Negotiating Committee was evaluating applications to reopen the Dvokolwako diamond mine and the Mpaka coal mine. An estimated 30 million metric tons of coking coal remained at the Mpaka Collieries, which had the capacity to produce 165,000 metric tons per year (t/yr). The sole coal producer, the Maloma Mine, switched from open pit to underground operations during 1999 and was producing at a rate of 480,000 t/yr of high-quality anthracite (James Hall, May 13, 1999, Coal leads the way as Swazi mines crank up mineral output, Business Day Online (Johannesburg), accessed June 18, 1999, at URL <http://www.bday.co.za/99/0513/world/w9.htm>).

¹Where necessary, values have been converted from Swazi emalangeni (E) to U.S. dollars at the rate of E5.30=US\$1.00 for 1998.

An Environmental Impact Assessment and Comprehensive Mitigation Plan was prepared for the Swaziland Greenstone Quarry by Michael Lee Enterprises (Pty.) Ltd. of Taiwan. The proposed green chert operation was in the Malolotja Nature Reserve in the Hhohho region.

Production of chrysotile asbestos from the Bulembe Mine, valued at \$10.7 million, was the country's major commodity by value followed by coal at \$4.6 million and crushed stone at \$2.3 million. The production of crushed stone for road building and construction stone decreased slightly during 1998. Stone production in 1999 was expected to increase with the approval for construction of the Nhlanguano-Lavumisa highway, the Ngwenya-Mbabane highway, and the Siteki-Mhlumeni road and continued work on the Mbabane-Manzini highway and the Maguga Dam.

Swaziland's electrical generation capacity and grid have been a problem for industrial development. In 1998, the Government signed an agreement with the Danish Cooperation for Environment and Development (DANCED) for the establishment of a Swazi National Energy Policy. The 2-year DANCED project was to begin in early 1999. The electricity generation capacity in Swaziland totaled about 60 megawatts installed in a number of coal and diesel and/or fuel oil thermal plants. Capacity was fueled by petroleum products and supplemented by electricity imported from South Africa. In 1999, power will also be imported from Mozambique with the connection to a 400-kilovolt transmission line transiting Swaziland.

Major Sources of Information

Ministry of Natural Resources and Energy
P.O. Box 57
Mbabane, Swaziland
Telephone: (268)-46-244
Fax: (268)-42-436
Geological Survey and Mines Department
P.O. Box 9
Mbabane, Swaziland
Telephone: (268)-42-411
Fax: (268)-45-215

TABLE 1
SWAZILAND: PRODUCTION OF MINERAL COMMODITIES 1/

Commodity 2/		1,994	1,995	1,996	1,997	1,998
Asbestos, chrysotile fiber	metric tons	26,720	28,570	26,014	25,888	27,693
Coal, anthracite	thousand metric tons	228	172	129	203	410
Diamond	carats	76,100	75,000	75,000	--	--
Stone, quarry products	thousand cubic meters	185	114	221	456	453

1/ Reported data from Swaziland Geological Survey and Mines Department. Includes data available through November 30, 1999.

2/ In addition to the commodities listed, modest quantities of crude construction materials (brick clay, sand and gravel) and pyrophyllite are produced, but output is not reported quantitatively, and information is inadequate to make reliable estimates of output levels.

TANZANIA

By George J. Coakley

The United Republic of Tanzania, including the semi-independent islands of Zanzibar, is located between Kenya and Mozambique on the east coast of Africa and has a land area of 886,040 square kilometers. In 1998, the area supported a population of 30.5 million with a gross domestic product (GDP) per capita of \$730 based on purchasing power parity estimates. The mining and petroleum sectors, which played a relatively small role in the chiefly agrarian economy of Tanzania, accounted for less than 3% of the total nonsubsistence workforce of around 170,000 and for about 5% of the GDP. In 1998, the value of mineral exports, primarily diamond (\$12.11 million), semiprecious gemstones (\$8.13 million), and gold (\$3.35 million), declined by 14% to \$23.60 million, down from \$27.52 million in 1997. Mineral exports represented 3.5% of total exports of all goods of \$679 million in 1998 (Jairo, 1999). Encouraged by more aggressive Government investment policies and the exploration successes reported in 1996 and 1997, mining was on the verge of becoming a significant part of the Tanzanian economy. Although the country's natural resources include coal, cobalt, diamond, gemstones, graphite, iron ore, natural gas, nickel, and phosphate rock, development of gold resources will be the focus of the mining industry in the next 5 years.

During 1998, the Government passed a new Mining Act of 1998 to replace the old Mining Act of 1979 (Newafrica.com, September 1999, Mining Laws of Africa—Tanzania Mining Act, 53 p., accessed January 6, 2000, at URL <http://www.newafrica.com/mining/laws/tanzania.pdf>). The new Act will be administered by the Ministry of Energy and Minerals through a new office of the Commissioner for Minerals. The petroleum sector is governed by the provisions of the 1980 Petroleum (Exploration and Production) Act. The Tanzania Investment Act of 1997 created the Tanzania Investment Centre, a one-stop center to promote, coordinate, and facilitate investment. Investments are now guaranteed against nationalization and expropriation. The Tanzania Investment Act sets corporate tax rate for the mining sector at 30% and provides additional customs rates, capital allowance deductions, depreciation, and other tax incentives (Tanzania Investment Centre, 1997). Mining royalties are set at 3% of netback value (net sales revenue), with a rate of 5% for diamond. No royalties are paid on cut and polished gemstones. The new Financial Laws (Miscellaneous Amendments) Act of 1997 also provided improved fiscal incentives for the mining sector. In October 1997, the Ministry of Energy and Minerals issued a new minerals policy giving priorities to private-sector initiatives, the rationalization and organization of artisanal and small-scale mining and product marketing, and new initiatives to mitigate the adverse environmental and social aspects of mining. The Ministry's vision statement included increasing mining contribution to the economy to more than 10% of the GDP and

establishing a value-added gemstone-cutting and jewelry-manufacturing industry. It emphasizes the role of the Government as a regulator, promoter, facilitator, and service provider to the private sector and not as a direct player in production activities. The National Environment Management Act of 1983 covered environmental matters and authorized a National Environmental Council to regulate environmental activities. Mining is not permitted in national parks or in the Ngorongoro Conservation Area, but is allowed by special permits in game reserves. The 1997 minerals policy document further strengthens the Government's commitment to the environmental and social sustainability of mining development and sets the stage for additional environmental regulatory and management programs.

The country has been successful in attracting mineral exploration and investment and since 1992 has triggered a "gold rush" in the greenstone belts at the southern end of Lake Victoria. Exploration companies from Australia, Canada, Ghana, South Africa, Sweden, and the United Kingdom have been very active in Tanzania, with foreign direct investment in the mining sector increasing from \$56.9 million in 1997 to \$95.9 million in 1998 and with more than 650,000 kilograms (kg) (21 million troy ounces) of gold resources identified in the eight largest exploration projects through 1998 (Ministry of Energy and Minerals of Tanzania, January 1999, Tanzania mineral sector developments, accessed February 7, 2000, at URL http://www.newafrica.com/mining/tanzania_miningdev.htm).

Historically, diamond and gold have been the most important minerals produced in Tanzania, with mining of semiprecious gemstones increasing in its relative importance in recent years. Tanzania also produced construction materials, including cement and other industrial minerals. Fuel mineral production in Tanzania has been limited to steam coal from the mine at Kawire and a small amount of petroleum refinery products. Mineral production statistics for the period from 1994 to 1998 are listed in table 1.

Commodity Review

Metals

Gold.—During the year, gold exploration and development planning dominated the industry news, with several companies announcing or extending the discovery of significant gold resources. With an annual production of nearly 30 metric tons of gold possible by 2001 and with additional potential for growth, Tanzania will become one of Africa's major gold producers.

The first of several likely new projects, the \$48 million Golden Pride Project, started up in November 1998 with the

capacity to produce 5,600 kilograms per year (kg/yr) of gold. The mine produced 198 kg of gold during the last quarter of 1998. Golden Pride was a 50-50 joint venture between Resolute Ltd. of Australia and Ashanti Goldfields Co. Ltd. of Ghana. Ashanti acquired its interest when it purchased Samax Resources Ltd. of Canada in November 1998 for \$135 million. The Golden Pride open pit development was based on an October 1997 mineral resource estimate of 33.41 million metric tons (Mt) of ore grading 2.56 grams per metric ton (g/t) gold and containing 85,530 kg gold, including an interim minable reserve totaling 12.43 Mt grading 2.62 g/t gold and containing 32,380 kg gold (Samax Resources Ltd., 1998, p. 4-6).

Ashanti's acquisition of Samax included Samax's Kukuluma and Matandani deposits that were located near Ashanti's Geita-Lone Cone property in Tanzania. Ashanti planned to combine the properties to bring a new open pit mining, leach, and carbon-in-pulp processing operation on-stream by 2001 producing up to 14,800 kg/yr at a total project capital cost of about \$165 million. Ashanti reported the results of exploration drilling at the Geita Project through March 31, 1999, as having identified an undiluted, in-situ mineral resource of 208,000 kg (6.7 million ounces). The resource is distributed among six deposits. The total measured, indicated, and inferred resource at Geita Hill was 22.5 Mt grading 2.6 g/t gold; Nyankanga, 16.2 Mt grading 4.4 g/t gold; Lone Cone, 6.2 Mt grading 2.7 g/t gold; Kukuluma, 8.6 Mt grading 3.3 g/t gold; Matandani, 10 Mt grading 2.6 g/t; and Area 3 West, 2.7 Mt grading 2.7 g/t (Ashanti Goldfields Co. Ltd., September 1999, The Geita project—Part 4—Exploration, accessed January 31, 2000, at URL <http://www.ashantigold.com/geita.htm>). In January 1999, Ashanti took out an option to acquire 60% of the adjacent Geita East property held by Tan Range Exploration Corp. of Canada subject to completing a bankable feasibility study by the end of 2001.

At yearend, Kahama Mining Corp. Ltd., owned by Sutton Resources Ltd., was still working on project financing for the largest gold deposit outlined to-date in Tanzania, the Bulyanhulu deposit with reported measured, indicated, and inferred resources of 17.55 Mt grading 13.14 g/t gold (Sutton Resources Ltd., 1998). Sutton completed a favorable feasibility study in 1998 and was initiating development plans on its \$211 million, 2,500 metric-ton-per-day underground Bulyanhulu Mine to be in production by 2000 at a rate of 9,330 kg/yr of gold. In March 1999, Barrick Gold Corp. of Canada purchased Sutton Resources, including the Bulyanhulu gold property, for approximately \$281 million (Barrick Gold Corp., March 27, 1999, Barrick acquires 91% of Sutton, Barrick Gold Corp., press release, accessed March 27, 1999, at URL http://www.barrick.com/barrick_glance/press_releases/docs/pr990327.cfm).

Pangea Goldfields Inc. (Canada) held about 36 gold exploration licenses in the greenstone belts south of Lake Victoria and had joint-venture agreements with the Anglo American Corp. of South Africa Ltd. to explore the Kahama/Chocolate Reef prospect where a resource, using a 0.5-g/t cutoff, of 26 Mt grading 2.3 g/t gold has been identified; Ashanti to explore the Bulyanhulu South (51%) and Rubondo (51%) properties; and Explorations Minière du Nord Ltée of Canada to explore the Kangele (50%) and the Tulawaka (30%) deposits. Pangea also had joint-venture agreements with Iscor

Ltd. of South Africa on the Suguti and Ushirombo properties, Ormonde Mining plc of Ireland on the Mguzi property where an inferred resource of 1.83 Mt grading 4.6 g/t gold has been calculated, and Randgold Resources Ltd. of the United Kingdom to explore the Golden Ridge deposit where a total resource of 46,655 kg (1.5 million ounces) gold had been estimated, of which the measured and indicated portion of the overall resource contains 31,100 kg (1.0 million ounces) of gold, in mineralization grading 2.73 g/t gold. Although terms differ from property to property, in general, the company joint venturing with Pangea can earn up to a 51% interest in the respective property by funding the exploration phase and from 60% to 75% by completing a bankable feasibility study within a 2- to 3-year period. In March 1999, Barrick acquired all Randgold's interest in the Golden Ridge joint venture, Pangea's most advanced project. Barrick acquired a 50% interest in the Golden Ridge property and had the right to increase its interest to 65% by completing a bankable feasibility study and by securing total project financing by September 2000. Barrick will continue to drill for further resource extensions at Golden Ridge in 1999. Golden Ridge is about 35 km southeast of Barrick's recently acquired Bulyanhulu property (Pangea Goldfields Ltd. 1999, Annual report for 1998, accessed December 18, 1999, at URL <http://www.pangeagoldfields.com/ir-fr.htm>).

During 1998, AngloGold Ltd. of South Africa focused its exploration program on proving up minable reserves at their two most advanced projects—Buzwagi, in the Kahama district, and Nyamulilima Hill, also known as Ridge 8, southwest of Ashanti's Geita Mine. Drilling efforts had outlined an initial total resource of 55,986 kg of contained gold at Buzwagi and 65,317 kg of contained gold at Nyamulilima Hill with additional drilling planned in 1999 to increase and define these deposits (AngloGold Ltd., 1999, p. 31).

In November 1997, East African Gold Mines Ltd. (EAGM) of Australia acquired all the shares in Afrika Mashariki Gold Mines Ltd. and its interest in the Nyabirama and Nyabigena prospects in the Musuma-Mara district near the town of Tarime, on the eastern side of Lake Victoria by the border with Kenya. EAGM, in partnership with Anglo American, the Commonwealth Development Corp. of the United Kingdom, and Lion Selection Group Ltd. of Australia, completed a feasibility study on its Nyabirama and Nyabigena projects in 1998. The company established a total indicated and inferred resource of 20.1 Mt grading 3.1 g/t gold, of which there is a probable ore reserve of 16.8 Mt grading 2.9 g/t gold. The feasibility study was based on an open pit mine and carbon-in-pulp processing plant producing 4,355 kg/yr of gold at a capital cost of \$52 million. The project was being delayed by a legal challenge to the Nyabirama mining license (Lion Selection Group Ltd., 1999, Investments—East African Gold Mines Ltd., Lion Selection Group Ltd. annual report for 1998, accessed January 22, 2000, at URL <http://www.lionselection.com.au/PDFS/ar-98.pdf>).

Tan Range Exploration Corp. of Canada held the rights to the Itetemia, Geita East, Luhala, Kabahalele, Mnekezi, and Mulehe concessions and continued with various stages of exploration during 1998. The Itetemia project with its Golden Horseshoe Reef mineralized zone, hosted in a banded to massive quartz sulfide zone with a carbonate component, was Tan Range's

most advanced project. Further exploration work in 1999 on Tan Range concessions will be carried out under option agreements with Ashanti Goldfields on Geita East, Barrick on Itetemia, and Newmont Gold Co. of the United States on the Luhala, Kabahele, Mnekezi, and Mulehe gold properties.

In other gold exploration activity, East African Gold Corp., a subsidiary of Spinifex Gold NL of Australia, reported initial results of its 1998 exploration program in the Lake Victoria gold field. They reported a total measured, indicated, and inferred resource of 3.7 Mt grading 3.26 g/t gold at the Buckreef/Rwamagaza project; a total measured, indicated and inferred resource of 10.47 Mt grading 1.34 g/t gold at the Kitongo project; and an inferred resource of 0.7 Mt grading 6.13 g/t gold at the Nyakafuru concession for a combined resource of more than 31,200 kg of contained gold (Lion Selection Group Ltd., June 19, 1999, Spinifex Gold NL—Projects, accessed January 22, 2000, at URL <http://www.lionselection.com.au/spxprojects.html>).

Tanganyika Gold NL of Australia continued work on its Buhemba project and on the Busolwa project on its Mawe Meru license, 40 km south of Geita. Near-surface resources at Buhemba were reported to be 11.45 Mt grading 2.03 g/t and containing 23.2 t of gold (African Mining, 1998). Anglo American also held a 14.9% equity interest in Tanganyika Gold and was committed to expend \$2 million during 1998 and 1999 in the exploration of Tanganyika Gold's Lupa Goldfield licences and on the Samena area near Geita. Tanganyika Gold also signed an option agreement with Ormonde Mining to explore Ormonde's Simba Sirori South prospecting license adjacent to the Buhemba property.

During 1998, Maiden Gold NL of Australia entered a joint venture with Avgold Ltd. of South Africa to explore Maiden's 11 prospecting licences in southern Lake Victoria greenstone environments, including the Nyanzaga prospect and the area around the old Jubilee Reef gold mine. Avgold purchased a 20% interest in Maiden with an option to acquire an additional 40% interest.

In the Lupa gold fields in southwestern Tanzania, Serengeti Diamonds Ltd. of Canada had joint-venture agreements with Ormonde Mining to explore the Lyaru, the Kasanga Bridge, and the Makhona-Nijwa gold prospects and with Anmercusa Explorations (Tanzania) Ltd., a wholly owned subsidiary of AngloGold. Anmercusa identified five exploration targets from the 1998 evaluation of historical airborne geophysical data held by Serengeti and conducted initial rotary air blast drilling on two of the targets, at the Razorback and the Gap prospecting licences, during 1998. Ormonde also had a farm-in agreement with Iscor Ltd. of South Africa, whereby Iscor could earn a 50% interest in the Ormonde's Mrangi prospecting license in the Seka area.

Nickel.—After the withdrawal of its joint-venture partner BHP Minerals International Exploration Inc. in 1997, Sutton Resources regained its 100% interest in the Kabanga and Kagera nickel-cobalt properties in northwestern Tanzania. During 1998, Anglo American conducted an aggressive exploration and engineering program on the Kabanga project under its 1997 agreement with Sutton to earn a 60% interest in Kabanga by committing to spend \$27 million, including at least \$7 million within 24 months, on exploration, feasibility studies,

and arrangement of project financing. Anglo American reported new preliminary resource estimates on the North and the Main deposit at Kabanga, using a 0.8% nickel cutoff grade, of 15.5 Mt grading 2.43% nickel, 0.30% copper, and 0.18% cobalt at North Kabanga and 5.8 Mt grading 1.50% nickel, 0.19% copper, and 0.16% cobalt at Main Kabanga. Anglo American's detailed prefeasibility study examining the potential for developing a mine that could produce 15,900 metric tons per year (t/yr) of nickel and 1,130 t/yr of cobalt for more than 15 years was continuing into 1999 (Sutton Resources Ltd., 1999).

Industrial Minerals

Cement.—In the cement sector, Tanzania was more than 95% self-sufficient in meeting its domestic demand. During 1998, Tanzania Portland, one of three producers in the country, was acquired by Scancem International of Sweden (41%) and the Swedish state agency Swedfund International (19%). Tanzania Portland, located outside of Dar es Salaam, had a capacity to produce 700,000 t/yr of cement. Tanga Cement, located on the northeastern coast, with a capacity of 500,000 t/yr of cement, was owned by Alpha Ltd. of South Africa (60%). The state-owned Mbeya Cement Works, located in the far southwest of the country, had a capacity of 300,000 t/yr of cement (International Cement Review, 1998, p. 131).

Gemstones.—Williamson Diamonds Mines Co. Ltd., owned by De Beers Centenary AG (75%) and by the State Mining Corp. (25%), operated the Williamson (Mwadui) Mine. Production levels at the Williamson Mine decreased by 20% in 1998 compared with that of 1997 as a result of heavy rains that flooded the mine and slimes dam early in the year. With the surficial gravels nearly depleted, De Beers was bulk sampling the main kimberlite pipe at Williamson to determine the future of the mine. Additional diamond exploration was being conducted by De Beers; Reunion Mining plc of the United Kingdom at Mabuki; Tan Range at the Tabora kimberlite pipe, 65 km southwest of the Williamson Mine; and Serengeti Diamonds of Canada.

Merelani, in Arusha, the center of the production of the semiprecious gem, tanzanite, with 42 small-scale mining operations, was the site of a major mining tragedy in 1998. In April, torrential rains flooded the working pits, killing an estimated 100 workers. The individual working plots typically measure 50 by 50 meters (m) and can be as deep as 90 m. Licensed and illegal artisanal miners were active at Merelani. The Ministry of Energy and Minerals indicated that the failure to clear all mine waste material from the mouth of the working pits contributed to the disaster. Some of the mines remained closed for the year, with a resulting upward impact on world prices for the popular blue-purple tanzanite. Tanzania was exporting between \$450,000 and \$700,000 per month in tanzanite material (Mining Journal, 1998b; Kibanga, Premy, July 6-12, 1998, Tanzanite mines back in operation after April accident, The East African [Nairobi], accessed July 13, 1998, at URL <http://www.nationaudio.com/News/EastAfrican/current/Regional/Regional7.html>).

Graphite.—Phoenix Minerals Ltd. of the United Kingdom closed its graphite mine near Arusha and put the mine up for

sale with 1 Mt of graphite reserves remaining (Mining Journal, 1998a). The mine, originally developed in 1995 at a capital cost of \$20 million mine, produced 6,776 t of graphite in its first full year of production in 1996. Sufficient reserves were initially identified for a 40-year operation at a mining rate of 15,000 t/yr of high-grade flake graphite of 97 to 98% purity (Ministry of Water, Energy and Minerals, Tanzania, 1998). The mine, however, ran into operational problems in 1997, and the last shipment of remaining stockpiled ore was made in February 1998 (Industrial Minerals, 1998).

Mineral Fuels

Coal.—Kiwiri Coal Ltd. operated the only significant coal mine at its underground Songwe-Kiwiri operation, at the northwest end of Lake Nyasa. Kiwiri Coal had a rated production capacity of 150,000 t/yr of coal or 93,000 t/yr of washed bituminous coal. All production was consumed at a mine-mouth power-generating plant. Planning was underway to expand the capacity of the powerplant from 6 megawatts (MW) to 18 MW (Hestor, 1998, p. 90-92).

Petroleum and Natural Gas.—During the past 2 to 3 years, the Government has been trying to privatize its controlling interests in petroleum refining and exploration. The state-owned Tanzanian Petroleum Development Corp. (TDPC) entered production sharing agreements with a number of companies to explore offshore oil and gas targets while reducing its maximum participation in joint-venture agreements to 25%. These included Antrim Resources Inc. of Canada on the Pemba-Zanzibar blocks; Canop Worldwide Corp. of Canada and its joint-venture partner, Paladin Resources plc. of the United Kingdom on the Dar es Salaam Basin; Tanganyika Oil Co. on the Rufiji and Mandawa Basins; Tullow Oil plc. of Ireland on the Mnazi Bay Block; Dublin International Petroleum Ltd. of Ireland; and Klosa of Dubai.

Ocelot Energy Inc. and Trans Canada Pipelines Ltd., a Canadian joint venture under contract to the Government, continued development of the \$300 million Songo Songo offshore natural gas production and processing project with the delivery of gas to a Dar es Salaam power station expected around the end of 2001. All five existing gas wells in Songo Songo were reworked and made production ready during 1997. Testing confirmed total gas deliverability of more than 2.8 million cubic meters per day (Mm³/d) at high pressure and a total reserves of more than 28 billion cubic meters of natural gas. The first phase of the project required only 1.12 Mm³/d of deliverability and 7 billion cubic meters of reserves, leaving capacity for subsequent phases of gas sales from Songo Songo. During 1998, acquisition of the right-of-way for a 12-inch pipeline from Songo Songo Island to Dar es Salaam was completed. The gas-fueled powerplant at Ubungu will have an electrical generating capacity of 150 MW. Ocelot had a production-sharing agreement with TPDC to market any excess gas not required for use on the Songo gas to electricity project (Ocelot Energy Inc., 1999, Projects—Tanzania, accessed September 22, 1999, via URL <http://www.ocelot.ca/projects/tanzania.HTM>).

Independent Power Tanzania Ltd. (IPTL) of Malaysia in a joint venture with the state-owned Tanzania Electric Supply Co.

was well under way on the construction of its \$160 million, 100-MW diesel-fueled powerplant. Discussions between IPTL and the Government over power rates to be charged to consumers from the plant were continuing into 1999.

In January 1998, TDPC signed an agreement with Tornado Resources Ltd. of Canada for development of the Nazi Bay natural gas-to-power project. Tornado will joint venture with Caterpillar Power Ventures International Ltd. on the project. The proposed \$32.5 million project would supply power to the Mtwara and Lindi Administrative Districts in southern Tanzania, which were unconnected to the main Tanzanian power grid. Gas reserves of 15.5 billion cubic meters of gas were originally identified at the Nazi Bay-1 Gas well during exploration in 1982, but further work was then suspended. The project will include reentry and production testing of the well, construction of a 15-MW powerplant at Mtwara, and construction and upgrading of transmission lines in the region (Alexander's Gas and Oil Connections, March 12, 1998, Tornado signs MOU with Tanzania on power project, accessed November 18, 1998, at URL <http://www.gasandoil.com/goc/company/cna81174.htm>).

The Tanzanian Government also agreed to purchase hydroelectric power from Uganda to develop transmission lines to new mines being developed in northern Tanzania (Dan Elwana, March 13, 1999, Kampala seeks new power customers, Daily Nation on the Web [Nairobi], accessed March 16, 1999, at URL <http://www.nationaudio.com/News/DailyNation/130399/Business/Business7.html>).

Outlook

The future outlook for the minerals sector in Tanzania is promising, stimulated by positive new mining and foreign investment legislation and by the success of mineral exploration in the country since 1996. Decisions on proceeding with future new mining developments, particularly for gold and nickel, however, will be subject to external market forces and world commodity prices. Lack of adequate infrastructure remains a problem, but efforts, supported by international development funds, have begun to upgrade harbors, pipelines, road, and railroad transport systems. The development of domestic natural gas resources may provide help in cost-saving energy import substitution and as a source of cheaper energy for new industrial developments.

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Major Publication

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TABLE 1
 TANZANIA: PRODUCTION OF MINERAL COMMODITIES 1/ 2/

(Metric tons unless otherwise specified)

Commodity 3/	1994	1995	1996	1997	1998 e/
Calcite	540	37	40 e/	40	40
Cement, hydraulic e/	490	320	1,100 r/ 4/	1,150 r/ 4/	1,200 4/
Clays:					
Bentonite e/	70	70	75	75	75
Kaolin	541	596	1,332	1,300	1,300
Coal, bituminous	45,000	43,200	52,000	35,000	35,000
Diamond 5/	17,177	49,538	126,670	116,750 r/ 4/	93,205 4/
Gemstones, excluding diamond 6/	48,509	111,403	142,160	106,537 r/ 4/	48,518 4/
Gold, refined	2,861	320	318	250	720 4/
Graphite	--	359	6,776	11,000	--
Gypsum and anhydrite, crude	7,536	1,052	8,765	8,800	8,800
Lime, calcined and hydrated	101	--	--	--	--
Limestone, crushed	648,474	1,062,081	120,000	120,000	120,000
Phosphate minerals:					
Apatite e/	--	6,700 e/	28,020	3,000	1,935
P ₂ O ₅ content	--	2,080 e/	8,686 r/ 4/	930 r/ 4/	600 4/
Salt, all types	84,289	105,000	86,700	119,710	97,000
Sand, glass e/	4,200	4,200	4,200	4,200	4,200
Soda ash e/	300	300	300	300	300
Tin, mine output, Sn content	9	3	-- e/	--	--

e/ Estimated. r/ Revised.

1/ Includes data available through December 1999.

2/ Estimated data are rounded to three significant digits.

3/ In addition to the commodities listed, modest quantities of unlisted varieties of crude construction materials (other clays, sand and gravel, and stone) presumably are produced, but output is not reported quantitatively, and available information is inadequate to make reliable estimates of output levels.

4/ Reported figure.

5/ Diamond figures are estimated to represent 70% gem-quality or semigem-quality and 30% industrial-quality stones.

6/ Precious and semiprecious stones produced included amethyst, chrysoprase, emerald, peridot, rhodolite, ruby, tanzanite, and tourmaline.

THE MINERAL INDUSTRY OF TOGO

By Philip M. Mobbs

Agriculture, mining, and trade continued to dominate Togo's economy. In recent years, phosphate production has accounted for about 6% of Togo's gross domestic product (GDP) compared with agriculture's about 30% of the GDP and commerce's about 20% to the GDP.

Togo's mineral industry included the mining of limestone for the cement clinker plant and the production of cement, clinker, and phosphate rock for the export market. There was some artisanal recovery of diamond and gold. Other mineral occurrences, including attapulgite, barite, bauxite, bentonite, brick clay, dolomite, garnet, gypsum, iron ore, kaolin, kyanite, limestone, manganese, marble, monazite, peat, rutile, silica sand, and dimension stone, were known, and the Government considered many of the occurrences to be potential small-scale operations (Ministry of Mines, Energy, and Water Resources, 1995).

The 1998 privatization of the Office Togolais des Phosphates (OTP) faltered. The Government planned a partial privatization of OTP in 1999. The alliance of the Broken Hill Proprietary Co. Ltd. and Resolute Ltd. of Australia held the Kabagni and Zogbegan exploration permits, and Coronation International Mining Corp. of the United Kingdom held the Pagala base metal license. At the beginning of 1998, International Tournigan Corp. of Canada held the Kara and Nadoba gold concessions.

For more extensive coverage of the mineral industry of Togo, see the 1996 Minerals Yearbook, Volume III, International Review of Africa and the Middle East.

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TABLE 1
TOGO: ESTIMATED PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity 2/	1994	1995	1996	1997	1998
Cement	350,000 3/	350,000 3/	413,000 r/ 3/	421,000 r/	565,000
Iron and steel, semimanufactures 4/	500	500	500	--	--
Phosphate rock, beneficiated product:					
Gross weight	thousand metric tons				
P ₂ O ₅ content	do.				
	2,149 5/	2,570 5/	2,731 5/	2,200	1,900
	800	930	980	800	600

r/ Revised.

1/ Includes data available through August 4, 1999.

2/ In addition to the commodities listed, Togo presumably produced a variety of crude construction materials (clays, sand and gravel, and stone), diamond, gold, and limestone for the cement plant, but output is not reported, and available information is inadequate to make reliable estimates of output levels.

3/ Produced from imported clinker.

4/ Iron rod production from semifinished metal.

5/ Reported figure.

THE MINERAL INDUSTRY OF

TUNISIA

By Bernedette Michalski¹

Production and processing of crude oil, mining of phosphate rock and manufacturing of its derivative products, resumption of operations at the Bougrine zinc-lead mine, and the partial privatization of a significant cement industry were the most important activities of the Tunisian mineral industry in 1998. All segments of the mineral industry combined contribute about 3% to the nation's gross domestic product.

Phosphate rock extraction was controlled and operated by the Government parastatal *Compagnie des Phosphates de Gafsa*, the largest company in Tunisia. *Le Groupe Chimique Tunisien* controlled phosphate processing through its Tunisian-owned *Société Industrielle d'Acide Phosphorique et d'Engrais* and *Société Arabe des Engrais Phosphates et Azotes*. *Société Minière du Nord-Ouest* operated a lead-zinc-barite mine at Boujabeur and a zinc mine at Hassine. The parastatal *Société du Djebel Djerissa* produced iron ore from the underground mine at Djerissa and from the open pit operations at Tamera and Douaria. The Government's hydrocarbon interests were overseen by *Enterprise Tunisienne d'Activités Pétrolières* (ETAP), which maintained an interest in each licensed tract.

Tunisia is currently in the ninth economic plan (1997-2001), and in this plan approximately 4% of its budget is slated to fund environmental projects. The incursion of phosphate mining tailing has seriously polluted the Bay of Gafsa, threatening coastal and fishing waters, as well as major underground aquifers. Other major polluting industries were cement, chemical, and steel manufacturers and petroleum refiners. All environmental safeguard activities are under the auspices of the Ministry of Environment and Land Use Planning. Actions taken by the Ministry include creating 10 industrial zones to locate centrally industries and to control their pollution; requiring mandatory environmental impact studies for new industrial projects; setting tight industrial operations standards to reduce future pollution; inspecting and fining those companies who pollute beyond the standards; and providing economic assistance to companies that invest in pollution controls (U.S. Embassy, Tunis, Tunisia, 1998).

The production of natural gas increased appreciably with the development of the Miskar Field, Tunisia's only domestic source of nonassociated natural gas. Crude oil, however, continued a slow decline as the nation's largest field, El Borma, nears depletion. This decline was partially offset in 1998 with the start of production from the El Biban Field in March. (See table 1).

The European Union dominated Tunisian trade, accounting for about 80% of total exports and 73% of total imports in 1998. France was Tunisia's main trading partner, accounting for 27% of Tunisia's total trade, followed by Italy, accounting for 20%.

Imports in 1998 totaled \$8 billion,¹ of which mineral imports accounted for \$813 million. Petroleum imports alone were valued at \$374 million. Exports in 1998 totaled \$5.5 billion. The value of mineral exports was \$957 million, of which phosphate rock and its derivatives were valued at \$553 million (Institut National de la Statistique, 1998). About one-third of Tunisia's export earnings was absorbed in debt servicing.

In September 1997, Breakwater Resources Ltd. of Canada acquired the assets of the Bougrine zinc-lead mine for \$19.3 million. Production resumed in May 1998 after low zinc prices forced suspension of mine operations in October 1996. The company produced about 40,000 metric tons (t) of zinc concentrates and 5,000 t of lead concentrates in 1998. Planned maximum production rate of 83,000 metric tons per year (t/yr) of zinc concentrates and 10,000 t/yr of lead concentrates was anticipated in 1999.

Tunisia's national demand for cement was some 4 million metric tons (Mt). Cement is produced by six plants with a combined capacity of 5.1 Mt. Two of the larger plants were privatized in 1998 with two more to follow in 1999. *Société des Ciments d'Enfidha*, 90 kilometers (km) south of Tunis near the eastern city of Sousse, and *Société des Ciments de Jebel Ouest*, 60 km south of Tunis, were privatized through international tender. Tunisia's largest plant, *Société des Ciments d'Enfidha*, was sold to Spain's *Uniland Cementera S.A.* for \$161 million for 88% equity; the other 12% was owned by the Islamic Development Bank. The nation's second largest cement producer with a national market share of about 25% and 47% in the Tunis area, *Société des Ciments de Jebel Ouest*, was sold to Portugal's *Cimentos de Portugal (Cimpor)* for \$231 million. Cimpor planned eventually to expand the 1.2 million-metric-ton-per-year (Mt/yr) capacity to 1.9 Mt/yr (Middle East Economic Digest, 1998b; *Cimentos de Portugal*, [undated], Tunisia, accessed March 20, 2000, at URL http://www.cimpor.pt/site_p/m_tun.html). The nearly \$400 million received from the sale of cement companies in 1998 and the future cement company proceeds from the privatization of the four remaining plants will be used mostly to boost a large infrastructure investment program (Financial Times, 1998).

Tunisian phosphate rock mining was primarily in the Gafsa region from nine open pit and underground sources. Phosphate rock exports were 937,200 t in 1998 compared with 1.25 Mt in 1997. Phosphoric acid exports totaled 1.29 Mt compared with 1.34 Mt in 1997. In 1998, diammonium phosphate exports totaled 840,500 t, and triple superphosphate exports were 759,300 t.

The Ministry of Industry expected an average of \$200 million to be invested yearly in the hydrocarbons exploration and

¹Deceased.

¹Where necessary, values have been converted from Tunisian dinars (TD) to U.S. dollars at a rate of TD0.92=US\$1.00.

production sector over the period 1998-2001 (Marek Enterprise Inc., May 6, 1998, [untitled], *African Business Daily*, accessed May 15, 1998, at URL <http://www.Marekinc.com/ABD050698.html>).

Petro-Canada signed a 2-year exploration agreement for a large concession in the Berkine Ghadames basin. This basin is relatively unexplored in Tunisia but has provided a number of substantial oil discoveries in neighboring Algeria. The company committed to spend \$5 million in Tunisia in 1998 and 1999 for exploration in the 7,200-square-kilometer Tataouine Block. Upon expiration of the initial 2-year term, Petro-Canada will have extension options.

Natural gas supplies were from domestic output, with Algerian pipeline transit fees for payment in kind, and supplemental purchases from Algeria. Until the development of the Miskar Field in 1996, associated natural gas from El-Borma Field was Tunisia's sole domestic natural gas source. A new domestic supply source will be the Chergui Field, where the successful completion of three appraisal wells in 1998 confirmed recoverable reserves of 2 billion cubic meters (Middle East Economic Digest, 1998a).

Crude oil production averaged 76,000 barrels per day (bbl/d) from 24 fields. The largest field was El-Borma operated by Italy's Azienda Generali Italiana Petroli, with an output averaged about 28,000 bbl/d of 41° API gravity crude oil. The offshore Ashtart Field, owned jointly by Atlantic Richfield Co (ARCO) and ETAP, accounted for nearly 22,000 bbl/d of 30° API gravity oil as the result of a \$210 million secondary development program. ARCO also owned 100% interest in the South Kerkennah exploration block immediately to the west of the Ashtart license.

Petroleum refining is for the present confined to a single 35,000-bbl/d-capacity refinery at Bizerte operated by the Société Tunisienne des Industries de Raffinage. The refinery output accounted for more than one-half of the nation's petroleum product requirements. The state-owned petroleum product distribution network, Société Nationale de Distribution de Pétrole, was slated for privatization by the end of 1999.

Tunisian phosphate rock reserves were 3.5 billion to 4 billion metric tons, or about 5% of global reserves. Tunisian crude petroleum reserves were 308 million barrels. Reserves of natural gas were 85 billion cubic meters (Arab Petroleum Research Center, 1998). The minable reserves at Bougrine were 5.3 Mt grading 11.7% zinc and 2.6% lead.

A total of 2,260 km of railway was the primary mode of transportation of phosphate rock to chemical plants and seaports. Highways within Tunisia totaled 17,500 km. Crude oil pipelines totaled 797 km, and natural gas pipelines totaled 742 km. Tunisia had an installed electrical generation capacity nearing 2,000 megawatts.

Tunisia is becoming an increasingly open, market-oriented economy because of structural adjustment supported by the International Monetary Fund and the World Bank. Investment in infrastructure is now a top priority and should result in increased economic growth. The outlook for Tunisia's cement industry is favorable as domestic infrastructure upgrading programs and expanding export markets are realized.

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Bulletin Mensuel de Statistique
Monthly 1997-1998
Tunis, Tunisia

TABLE 1
TUNISIA: PRODUCTION OF MINERAL COMMODITIES 1/

(Thousand metric tons unless otherwise specified)

Commodity 2/		1994	1995	1996	1997	1998
METALS						
Iron and steel:						
Iron ore and concentrate, gross weight		288	224	238	252	220
Fe content		129	122	129	137	119
Metal:						
Pig iron		154	162	151	152	100 e/
Steel, crude		184	201	187	195	122
Lead, mine output, Pb content	metric tons	2,856	6,601	4,764	1,424	4,272
Silver metal, primary e/	kilograms	2,500	4,000	3,000	1,000	1,000
Zinc:						
Ore, gross weight	metric tons	23,379	80,446	58,044	5,389	57,036
Zn content	do.	14,548 r/	44,244	31,920	2,967	31,368
INDUSTRIAL MINERALS						
Barite	do.	15,732	10,825	15,360	12,841	8,011
Cement, hydraulic		4,606	4,998	4,566	4,431	4,590
Clays, construction e/		350	350	350	350	350
Fertilizers:						
Triple-superphosphate		830	818	791	748	767
Phosphoric acid		986	1,018	1,093	984	1,184
Diammonium-phosphate		741	830	928	745	919
Ammonium nitrate		112	193	186	349	156
Fluorspar, acid grade	metric tons	676	1,856	720	1,426	1,190
Gypsum e/	do.	100,000	100,000	100,000	100,000	100,000
Lime e/		600	600	600	600	600
Phosphate rock:						
Gross weight		5,565	7,241	7,167	6,941	7,901
P ₂ O ₅ content e/		1,712	2,181	2,150	2,140	2,370
Salt, marine		414	481	477	393	473
MINERAL FUELS AND RELATED MATERIALS						
Gas, natural:						
Gross	million cubic meters	354	335	1,027	1,866	1,950
Dry e/	do.	250	250	800	1,500	1,500
Petroleum:						
Crude	thousand 42-gallon barrels	33,660	32,690	32,229	26,841	27,776
Refinery products:						
Liquefied petroleum gas	do.	1,545	1,465	1,573	1,353	1,355 e/
Gasoline	do.	2,917	2,846	3,040	3,179	3,180 e/
Kerosene	do.	1,057	1,035	1,012	827	830 e/
Distillate fuel oil	do.	4,003	4,297	4,261	4,842	4,845 e/
Residual fuel oil	do.	3,876	4,300	4,292	3,956	3,960 e/
Other e/	do.	448	568	551	1,995	2,000 e/
Total	do.	13,846	14,511	14,729	16,152	16,170 e/

e/ Estimated.

1/ Data available as of July 1, 1999.

2/ In addition to the commodities listed, a variety of crude construction materials (sand and gravel and stone) was produced, but output was not reported, and available information was inadequate to make reliable estimates of output levels.

THE MINERAL INDUSTRY OF

UGANDA

By Philip M. Mobbs

Uganda was a modest producer of cement, columbium-tantalum, gold, and steel. In 1998, the growth rate of the gross domestic product (GDP) was estimated to have reached 5.6% despite the adverse affect on agriculture of the El Niño weather events that began in 1997 (World Bank, June 10, 1999, Macroeconomic profile for Uganda, accessed October 5, 1999, via URL <http://wbln0018.worldbank.org/afr/aftbrief.nsf>).

Agriculture accounted for about 44% of the GDP of this east African country of 22 million people (Wrong, 1998).

Mineral industry activities in Uganda are administered by the Ministry of Natural Resources. The Ministry's Department of Geological Survey and Mines issues prospecting, location, and mineral dealer licenses; mining leases; and water rights. The Ministry's Commissioner for Energy and the Directorate of Energy and Mineral Development sets energy sector policies. The Uganda Investment Authority facilitates investment ventures.

The Government actively promoted the development of the nation's mineral resources. Cobalt, gold, marble, nickel, phosphate rock, and vermiculite prospects have garnered international interest. Additional Ugandan mineral resources reported to have the potential to attract commercial investment include diatomite, gypsum, iron deposits, mica, and salt (Hester and others, 1996). Although prospecting licenses were staked all over the country, the mining licences were in the southeast and southwest. Active anti-Government rebellions continued in the north and west, adversely affecting exploration activity.

The Government was attempting to help local mining entrepreneurs secure international joint-venture partners and financing; however, the collapse in international interest in gold exploration opportunities in Uganda reflected the drop in the price of gold during 1998, and a number of local companies were saddled with gold concessions they were unable to farm out. Additionally, to the Government's dismay, some gold prospecting licenses appear to be used by international companies merely to maintain a presence in the gold districts instead of being active mineral prospects (Crespo Sebunya, March 1998, The riddle of Ugandan gold, *NewAfrican*, accessed August 7, 1998, at URL <http://www.africalynx.com/icpubs/na/mar98/namb0302.htm>).

Kasese Cobalt Co. Ltd. (KCCL) continued to build the facility to recover cobalt from Kilembe Mine pyrite concentrates stockpiled near the Kasese railhead in southwestern Uganda; however, construction was disrupted and delayed by rebel attacks in the area twice during the year (Canadian Corporate News, August 4, 1998, Banff Resources Ltd.—Kasese cobalt project possible construction delay, accessed November 30, 1998, at URL <http://www2.cdn-news-com/scripts/ccn-release.pl?1998/08/04/0804067n>). Commercial production of cobalt was scheduled to begin in 1999 at a rate of about 1,000 metric tons per year.

Gold was recovered by artisanal miners in the northeast and along the western border. Catalyst Ventures Corp. of Canada held an option to acquire a 100% interest in a Kaabong area gold concession from Oslo International Investments Ltd. In December, Catalyst Ventures also obtained exploration rights to the adjacent Lopedo prospect when Branch Energy Ltd. of Uganda withdrew from the concession. Nabisoga Mining Ltd., an affiliate of Uganda Gold Mining Ltd. of Canada continued to explore the Kyakiddu property and in June entered into a joint venture with Gold Empire Ltd. of Uganda on the Bushenyi Properties, a package of 22 gold concessions. New Ensign Resources Ltd., an affiliate of Glencar Mining plc of Ireland, continued exploration on its four concessions in southeastern Uganda. International Roraima Gold Corp. of Canada was working on 20 gold prospects, 17 of which were being funded by ISCOR Ltd. of South Africa. Big Star Energy Inc. of Canada (formerly Dobrana Resources Ltd.) withdrew from the Luwero gold prospect, and Rift Resources Ltd. of Canada wrote off all of its exploration interests in Uganda.

Eight nickel prospecting concessions were under exploration by Ruwenzori Exploration (Uganda) Ltd.. Ruwenzori was a joint venture of Avmin Africa Holdings B.V. (70%), a subsidiary of Avmin Ltd. of South Africa, and Nhlanhla Ltd. of Uganda (30%).

In February, Canmin International Corp. of the Cayman Islands, a subsidiary of International Business Investments Corp. of Canada (IBI), acquired an option to earn 70% interest in the phosphate and vermiculite prospecting license on the Bukusu Carbonatite Complex from International Mining and Development of Canada (formerly IFMB) which retained 30% interest in the prospect. IBI reported phosphate resources at Busumbu on the Bukusu Carbonatite of 5.5 million metric tons (Mt) at an average grade of 15% P_2O_5 and 3 Mt at an average grade of 11% P_2O_5 (International Business Investments Corp., 1998). Resources at the adjacent Namekara vermiculite deposit were reported to be 2.7 Mt (International Business Investments Corp., March 29, 1999, IBI Corporation reports in excess of two million tonne vermiculite resource, press release, accessed March 31, 1999, at URL http://biz.yahoo.com/bw/990329/ibi_corp_1.html).

Petrel Resources plc of Ireland acquired a 10% interest in the Block 3 concession in the southern Lake Albert Basin of Heritage Oil and Gas Ltd., a London-based Bahamian company. In 1998, the Heritage/Petrel partnership completed a seismic survey on the concession. Ownership of the production-sharing agreement for Block 2 in the northern portion of the Lake Albert region changed hands during the year. In August, Hardman Resources NL of Australia, the parent of Hardman Petroleum (Uganda) Pty. Ltd., acquired an additional 45% interest in Block 2 when it bought former partner Planet Oil International plc of the United Kingdom. In October, Golden

Gate Resource Ltd. of Australia acquired the 10% interest in the Block formerly held by Balmain Resources Pty. Ltd. of Australia. During 1998, the joint venture completed an environmental study of the concession and contracted for a seismic shoot in 1999.

Uganda's surface transportation was adversely affected by the El Niño torrential rains and associated flooding that damaged bridges and highways and periodically halted rail traffic to landlocked Uganda. The rail line from Uganda to the seaport at Mombasa, Kenya, was reopened in July, after a 2-month closure. A rail ferry connected Port Bell, near Kampala, with Mwanza, Tanzania, which was connected to Dar Es Salaam, Tanzania, by rail; however, from February through August 1998, the rail segment in Tanzania had been under repair owing to flood damage (Awori, 1998). In September, the Uganda Railways suspended operations along the Kampala-Kasese line, forcing industry in western Uganda, including Hima Cement Co. and the KCCL operation, to depend entirely on road transportation (A. Mutumba-Lule, September 7, 1998, [untitled], East African, accessed September 11, 1998, at URL <http://www.nationaudio.com/News/EastAfrican/Current/Maritime/MA10.html>).

With its growing economy, Uganda has been subject to electric power deficits since the early 1990's. Power was generated at the Owen Falls hydroelectric dam, supplemented by smaller hydroelectric generation facilities near Kabale and Kasese, and the diesel-fired electricity-generating plants near Arua, Kampala, Kitgum, Mbale, Moroto, Moyo, and Nebbi.

Uganda's economy continues to expand despite the unrest in the Central African region and the rebellion in northern Uganda. Its varied mineral resources are underdeveloped, but it is expected that the Ugandan mineral industry will diversify through the coming years. Development of cobalt, gold, and nickel projects could attract additional international interest and investment in the nation's mineral industry.

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Wrong, Michela, 1998, So much done, so much still to do: *Financial Times* [London], October 2, p. XXII.

Major Sources of Information

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Uganda Investment Authority
The Investment Centre
P.O. Box 7418
Kampala, Uganda
Telephone: (256) (41) 251-562, 234-109
Fax: (256) (41) 342-903

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Mining Journal, 1996, country supplement, Uganda, Renaissance in mining: *Mining Journal* [London], v. 326, no. 8373, April 12, 16 p.
Onyango, Patricia, 1997, The New Uganda trade and investment opportunities, mining sector profile: Uganda Investment Authority, Kampala, Uganda, January, 12 p.
Tuhumwire, Joshua, 1996, Uganda: Gold and base metal opportunities: Department of Geological Survey and Mines, Entebbe, Uganda, 14 p.

TABLE 1
UGANDA: PRODUCTION OF MINERAL COMMODITIES 1/ 2/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996 e/	1997 e/	1998 e/
Cement, hydraulic	42,000	85,000	180,000 r/	203,000 r/	210,000
Columbium-tantalum kilograms	435	1,842	2,000	2,000	1,500
Gold do.	1,627	1,506	2,954 3/	3,000 3/	2,500
Gypsum	201	1,538	2,000 r/	2,000 r/	2,000
Iron ore	--	7	200 3/	200 3/	300
Lime, hydrated and quick	163	970	1,000	1,000	1,000
Limestone e/	38,000	78,000	135,000	245,000 r/	300,000
Phosphate minerals, apatite	--	20	-- 3/	-- 3/	(4/)
Salt	10	10	10	10	5
Steel	10,000	12,000	12,000	15,000	15,000
Tin, mine output, Sn content	3	43	(4/)	(4/)	(4/)
Tungsten, mine output, W content	12	17	-- 3/	-- 3/	--

e/ Estimated. r/ Revised.

1/ Includes data available through October 7, 1999.

2/ In addition to the commodities listed, the following are presumably produced but information is inadequate to estimate output: clay, copper content of slag, corundum, garnet, gemstones, gravel, kaolin, marble, ruby, sand, and vermiculite.

3/ Reported figure.

4/ Less than 1 unit.

THE MINERAL INDUSTRY OF

ZAMBIA

By George J. Coakley

Zambia is a landlocked country in southern African with an area of 753,000 square kilometers, 9.6 million people, and a per capita gross domestic product (GDP) based on 1998 purchasing power parity estimates of \$880.¹ Overall, mining and quarrying accounted for about 6% of real GDP and about 10% of total employment. The mining sector was dominated by copper and cobalt production, with exports of these two commodities accounting for 77% of total exports of \$873 million in 1998 (Zambia Investment Center, April 19, 1999, Zambia—Country profile, accessed February 12, 2000, at URL <http://www.zic.org.zm/profile.htm>). Zambia ranked as the world's largest producer of cobalt, 12th in copper, and as one of the top producers of gem-quality emeralds in 1998. Besides copper and cobalt, Zambia produced a wide variety of metallic and industrial mineral commodities, as well as coal. (See table 1.)

The Government has been successful in privatizing most of its state-owned mining assets, with the exception of the two largest producing divisions of Zambia Consolidated Copper Company Limited (ZCCM). Operational and financial problems at ZCCM, which led to a 29% decrease in refined copper production levels during 1998, and a 40% drop in world market prices for copper forced ZCCM to seek financial assistance from the Government by yearend to avoid the threat of bankruptcy. The Zambian Privatization Agency (ZPA) had been successful in selling off about half of ZCCM assets during 1997. These included the spinoffs of the Konkola Deep Mining Project to the Anglo American Corp.; the Konkola North Mine and the Chambishi cobalt plant to Anglovaal Minerals Ltd. (Avmin) of South Africa; the Kansanshi Mine to Cyprus Amax Minerals Co. of the United States; the Chibuluma Mine to Metorex Ltd., the Crew Development Corp. of Canada's South African subsidiary; the Luanshya Mine and Ndola Precious Metals Plant to the Indian zinc producer Binani Group; and the Chambishi Mine to the China National Non-Ferrous Metals Corp., operating under NFC Africa Mining plc, a new company (Mining Journal, 1999). During 1998, ZPA continued negotiations with the Kafue Consortium, which comprised Avmin, Phelps Dodge Corp. of the United States, Canada's Noranda Inc., and the Commonwealth Development Corp. of the United Kingdom, over the sale of the Nchanga and the Nkana Divisions. This package represented over half of ZCCM production capacity, which was equal to about 175,000 metric tons per year (t/yr) of copper cathode and 2,000 t/yr of finished cobalt and included five underground mines and one open pit mine, associated concentrator facilities, a tailings leach plant, a copper smelter and refinery, an acid plant, and a cobalt plant. ZPA ended negotiations, and the Kafue Consortium disbanded

in early June 1998 after the Government rejected the final Kafue offer to invest more than \$1 billion in the operations, saying the \$131 million cash component of the offer was too small (Noranda Inc, May 29, 1998, Phelps Dodge and Noranda withdraw from Kafue Consortium, press release, accessed June 2, 1998, at <http://www.newswire.ca/releases/May1998/29/c7207.html>). Anglo American, which retained a 27% interest in ZCCM through Zambia Copper Investments Ltd., its subsidiary, continued unsuccessfully to attract other international mining companies with which to submit a new joint venture bid on the Nkana-Nchanga package. Depressed copper and cobalt market prices and the increased political risk from wars in neighboring Angola and Congo (Kinshasa) contributed to the difficulty in attracting new investors.

Colossal Resources Ltd. of Canada shut down its Kabwe cobalt tailings retreatment plant after only 1 year of operation. Reunion Mining plc. of the United Kingdom increased gold production from its Dunrobin gold mine by more than 3½-fold from 1997 to 620 kilograms prior to being bought out by Anglo American. First Quantum Minerals Ltd. of Canada commissioned its Bwana Mkubwa copper mine in March 1998 and reached full operating capacity of 800 metric tons per month (t/mo) of cathode copper and 6,000 t/mo of surplus sulfuric acid by yearend (First Quantum Minerals Ltd., 1999). Prior to privatization of its assets, ZCCM provided a comprehensive listing of its copper and cobalt reserves (table 2) and resources (table 3) in its 1997 annual report.

For more extensive coverage of the mineral industry of Zambia, see the 1997 Minerals Yearbook, Volume III, Mineral Industries of Africa and the Middle East.

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Mining Journal, 1999, Zambia, *in* Africa annual review supplement: Mining Journal [London], v. 333, no. 8538, July 2, p. 67-70.

Major Sources of Information

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¹Where necessary, values have been converted from Zambian kwacha (K) to U.S. dollars at the rate of K1,429=US\$1.00 for 1998 and K1,697=US\$1.00 for 1997.

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Major Publication

Investment Opportunities in the Mineral Sector of Zambia,
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Zambia, 1998, 4 p.

TABLE 1
ZAMBIA: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997	1998
METALS					
Beryllium: beryl e/ kilograms	857	1,000	1,000	800	800
Cobalt: 2/					
Mine output, Co content	3,600	5,908	6,959	6,037	11,900
Metal, Co content	2,639	2,934	4,611	4,386	5,011
Copper: 2/ 3/					
Mine output, Cu content:					
By concentration or cementation	289,800	254,000	276,000	288,900	230,000
Leaching (electrowon)	83,400	62,000	58,000	64,000	50,000
Total	373,200	316,000	334,000	352,900	280,000
Metal:					
Smelter, primary:					
Electrowon (low grade)	25,342	65,400	73,900	61,140	51,736
Other	241,036	234,500	250,300	220,327	206,871
Total	266,378	299,900	324,200	281,467	258,607
Refinery, primary:					
Electrowon	67,255	62,000	58,000	63,736	80,709
Other	284,784	266,000	276,000	268,553	248,820
Total	352,039	328,000	334,000	338,400	240,500
Gold: 2/ kilograms	124	91	119	290 e/	765 e/
Selenium, refined, gross weight 2/ do.	21,115	18,550	20,016	15,161	14,670
Silver: 2/ do.	10,002	8,676	9,410	6,684	8,363
INDUSTRIAL MINERALS					
Cement, hydraulic	280,000 4/	312,000 r/ 4/	348,000 r/ 4/	384,000 4/	351,000
Clays:					
Brick e/	3,000	3,000	3,000	3,000	3,000
Building, not further specified e/	27,000 4/	30,000	30,000	30,000	30,000
China and ball e/	200	200	200	200	200
Gemstones: e/					
Amethyst kilograms	366,000 4/	350,000 e/	1,198,354	699,343	800,000 e/
Aquamarine do.	21 4/	200	866	--	-- e/
Beryl do.	1,000 e/	2,000 e/	4,544	1,527	2,000 e/
Emerald do.	160 4/	180	6,000	7,000	7,000 e/
Garnet do.	5,000 e/	5,000 e/	13,701	2,467	3,000 e/
Tourmaline do.	--	2,000 e/	4,150	--	--
Gypsum e/	11,200	11,000	11,000	11,000	11,000
Lime, calcined e/ thousand tons	195 4/	200	200	200	200
Limestone (cement and lime) e/ do.	710	800	800	800	800
Magnetite, gross weight e/	1,070 4/	1,000	1,000	1,000	1,000
Nitrogen, N content of ammonia e/	3,000	3,000	3,000	3,000	3,000
Sand and gravel, construction e/ thousand tons	117 4/	200	200	200	200
Stone, construction:					
Limestone, crushed aggregate e/ do.	668 4/	700	700	700	700
Other e/ do.	700	700	700	700	700
Sulfur:					
Pyrite concentrate:					
Gross weight	55,572	69,228	78,971 r/	69,059	72,366
S content (42%) e/	22,062 4/	28,314 5/	33,200 r/	29,005	30,394
Sulfuric acid: 5/					
Gross weight	224,838 r/	218,252 r/	206,572 r/	178,482	134,000
S content (32.6%)	73,300 r/	71,150	67,340 r/	58,185	43,684
Total, S content	95,362 r/	92,464 r/	100,540 r/	87,190	74,078
Talc e/	76 4/	80	80	80	80
MINERAL FUELS AND RELATED MATERIALS					
Coal, bituminous e/ thousand tons	163 4/	141	100	10	50
Petroleum, refinery products e/ 2/ thousand 42-gallon barrels	5,300	5,000	5,000	5,000	5,000

e/ Estimated. r/ Revised.

1/ Table includes data available through December 15, 1999.

2/ Data are for year beginning April 1 of year stated.

3/ Terms are used as defined by the International Copper Study Group.

4/ Reported figure.

5/ From ZCCM Nkana and Chambishi acid recovery plants.

TABLE 2
ZAMBIA: ZAMBIA CONSOLIDATED COPPER MINES LIMITED
ORE RESERVES BY MINE, AS OF MARCH 31, 1997

(Thousand metric tons)

Mine, by type of development	Gross weight	Copper (percent)	Cobalt (percent)
Nchanga:			
Fully developed	7,596	5.37	--
Partly developed	10,878	5.16	--
Undeveloped	47,908	3.05	0.56
Total	66,382	3.66 1/	0.56
Konkola:			
Fully developed	1,293	3.82	--
Partly developed	5,989	4.17	--
Undeveloped	26,288	3.88	--
Total	33,570	3.93 1/	--
Mufulira:			
Fully developed	1,134	3.18	--
Partly developed	6,613	3.28	--
Undeveloped	24,229	2.97	--
Total	31,976	3.04 1/	--
Nkana:			
Fully developed	2,187	2.02	0.12
Partly developed	11,869	2.03	0.11
Undeveloped	65,420	2.32	0.15
Total	79,476	2.26 1/	0.14
Chibuluma:			
Fully developed	280	3.33	0.10
Partly developed	470	3.20	0.13
Undeveloped	685	4.70	0.12
Total	1,435	3.82 1/	0.12
Luanshya:			
Fully developed	569	2.15	--
Partly developed	2,758	2.25	--
Undeveloped	18,218	2.37	--
Total	21,545	2.35 1/	--
Baluba:			
Fully developed	1,450	2.71	0.20
Partly developed	2,658	2.56	0.23
Undeveloped	26,560	2.45	0.17
Total	30,668	2.47	0.18
Grand total:	265,052	2.96 1/	XX
Of which:			
Fully developed	14,509	XX	XX
Partly developed	41,235	XX	XX
Undeveloped	209,308	XX	XX

XX Not applicable.

1/ Weighted average.

Notes--Ore reserves are defined as those tonnages that meet the definition of ore and are available for mining existing or approved planned financed facilities. ZCCM's reserves are quoted as in situ grades and tonnages and are not factored for dilution and/or mineralization left in the ground owing to unfortunate shapes or attitude or as pillars.

Source: Zambia Consolidated Copper Mines Limited, 1997 company annual report, p. 58.

TABLE 3
ZAMBIA: ZAMBIA CONSOLIDATED COPPER MINES LIMITED 1/
MINERAL RESOURCES BY MINE, AS OF MARCH 31, 1997

(Million metric tons)

Mine, by type of development	Gross weight	Copper (percent)	Cobalt (percent)
Nchanga:			
Underground	41	3.0	--
Open pits	53	3.2	--
Unclassified (Open-pit or underground)	39	2.6	--
Refractory ore (CRO)	180	1.2	--
Tailings dumps--No. 2, 3, and 4)	104	0.8	--
Total	417	1.5 2/	--
Konkola:			
Kirila Bombwe	297	3.8	0.07
Konkola	30	2.5	--
Saddle Lode-Konkola North	50	2.6	0.09
Fitwaola	3	3.5	--
Konkola South	5	2.0	--
Total	385	3.5 2/	XX
Mufulira:			
Ore body extensions	41	3.1	--
Oxide mineralization--Mufulira East	4	2.6	--
Mufulira West	17	1.5	--
Total	62	2.6 2/	--
Nkana:			
Extensions	118	2.4	0.12
Oxide caps	11	3.1	--
Nkana slag dump	20	1.1	0.15
Total	149	2.3 2/	XX
Chibuluma:			
West	2	2.5	0.12
South	9	3.9	--
Total	11	3.6 2/	XX
Chambishi:			
Main	45	2.6	--
West	46	2.2	--
Southeast	45	2.4	--
Total	136	2.4 2/	--
Luanshya:			
Extensions	24	2.4	--
Mashiba	4	2.5	--
Oxide mineralization	8	2.6	--
Slag dump	9	0.7	0.40
Total	45	2.1 2/	XX
Baluba:			
Extensions	2	2.1	0.15
Oxide mineralization	23	2.3	--
Total	26	2.3	XX
Grand total	1,231	2.4 2/	XX

XX Not applicable.

1/ May not add to totals shown because of independent rounding.

2/ Weighted average.

Note--Mineral resources are defined as those materials which have been examined in sufficient detail to establish their mode of occurrence, size, and essential qualities and include reclamation material already mined or treated for which there is a reasonable expectation of future exploration. Before such mineral resources can be transferred to the ore reserve category, investigation into the feasibility of economic exploration must be made, and additional investments incurred. ZCCM's resources are quoted as in situ grades and tonnages and are not factored for dilution and/or mineralization left in the ground owing to unfortunate shapes or attitudes or as pillars.

Source: Zambia Consolidated Copper Mines Limited, 1997 company annual report, p. 58.

THE MINERAL INDUSTRY OF

ZIMBABWE

By Philip M. Mobbs

Zimbabwe's economy was ravaged by problems, including the devalued Zimbabwe dollar, commercial lending rates exceeding 40%, inflation exceeding 30%, hikes in power (a 67% fuel price increase and a 33% electricity price increase) and transportation costs, and a high unemployment rate (Jensen, 1999; Farai Makotsi and Nqobile Nathi, *Financial Gazette*, August 7, 1998, Siege mentality in corridors of power as nation teeters on brink of economic turmoil, accessed August 8, 1998, at URL <http://www.africaonline.co.zw/fingaz/stage/archive/980808/national22114.html>). In April, the second phase of the Zimbabwe Programme for Economic and Social Transformation (ZIMPREST) was inaugurated. ZIMPREST was proposed to encourage economic growth and restructure Government; however, in 1998, the national gross domestic product (GDP) fell to \$6.5 billion,¹ down from the \$8.2 billion posted in 1997 (World Bank, September 9, 1999, Zimbabwe at a glance, accessed November 26, 1999, at URL <http://www.worldbank.org/data/countrydata/countrydata.html>). The devaluation of the Zimbabwe dollar manifested itself in increased costs of imports, including electric power, mineral fuels, and mining equipment and supplies.

Zimbabwe was a major contributor to the world supply of chrysotile asbestos, ferrochromium, and lithium minerals. Gold was the country's leading income-producing mineral. Gold production increased slightly to 25 metric tons (t), despite the closure of several large mines. Most of the country's mineral companies were export oriented and subject to world market fluctuations. Despite extensive diversification in 1998, the mineral industry again was battered by declining international prices for precious metals, higher labor and power costs, prohibitive interest rates, and spiraling inflation. Zimbabwe's mining companies continued to follow survival strategies. Mineral operations were scaling down to cut costs and to attempt to remain economically viable.

Structure of the Mineral Industry

All mining activities come under the Mines and Minerals Act (Chapter 165) (1961), its amendments, and associated regulations. The Ministry of Mining, Environment, and Tourism is responsible for the mining sector. All mineral rights are vested in the state through the President of Zimbabwe. Investment projects are sanctioned by the Zimbabwe Investment Center. The Gold Trade Act gives the Reserve Bank of Zimbabwe a monopoly on purchasing and exporting all gold produced in Zimbabwe. The Government's Minerals Marketing Corp. Zimbabwe handles most other mineral exports.

¹Where necessary, values have been converted from Zimbabwe dollars (Z\$) to U.S. dollars at the average exchange rate of Z\$23.5=US\$1.00 in 1998 and Z\$12=US\$1.00 in 1997.

The state-owned mining company, Zimbabwe Mining Development Corp. (ZMDC) had an interest in a number of mining operations, and the Government's Industrial Development Corp. of Zimbabwe Ltd. had several subsidiary companies operating in the industrial mineral sector.

Zimbabwe had a significant local mining industry. More than 500 gold mining operations were registered. Production from the large mines of Ashanti Goldfields Co. Ltd. of Ghana, Kinross Gold Corp. of Canada, Lonrho Zimbabwe Ltd., and Rio Tinto Zimbabwe Ltd. dominated the gold sector, and the numerous medium- and small-scale producers contributed about 10% to the nation's formal gold production. Alluvial gold panning was Zimbabwe's rural alternative to subsistence farming. The Mining (Alluvial Gold) (Public Streams) Regulations (1991) authorize selective alluvial gold mining, but extensive riverbank erosion and stream siltation resulted from uncontrolled mining activity.

Commodity Review

Despite the difficulties permeating the mineral industry, a number of mining companies continued exploration in Zimbabwe, primarily for diamond or gold. These including Ashanti Goldfields Zimbabwe (Pvt.) Ltd.; Barrock Mine (Pvt.) Ltd., a subsidiary of Mandarin Goldfields Inc. of Canada; Boulder Mining Co. (Pvt.) Ltd.; Casmyn Mining Zimbabwe (Pvt.) Ltd.; and the joint venture of Cambrian Resources of Australia and Prospecting Ventures Ltd., a subsidiary of Anglo American Corp. of South Africa Ltd. (AAC). Also active were Consolidated African Mining Corp. of the United Kingdom; the joint venture of Falconbridge Exploration Zimbabwe (Pty.) Ltd., a subsidiary of Falconbridge Ltd. of Canada, and NAR Resources Ltd. of Canada; Kimberlitic Searches Ltd.; the joint venture of Rio Amarillo Mining Ltd. of Canada, Mandarin Goldfields, and Picard Holdings Ltd.; and the joint venture of Trillion Zimbabwe (Pvt) Ltd., a subsidiary of Trillion Resources Ltd. of Canada; Nickelodeon Minerals Inc. of Canada; Skeena Resources Ltd of Canada; and Cratonic Zimbabwe Resources (Pvt.) Ltd., a subsidiary of Delta Gold NL of Australia. Catalyst Ventures Corp. of Canada was divesting its gold exploration properties, and Rift Resources Ltd. of Canada wrote off its exploration joint venture with Reunion Mining PLC of the United Kingdom.

Metals

Copper.—Despite mounting fiscal problems, Mhangura Copper Mines Ltd. continued its \$10 million rehabilitation program. The Government paid off a \$13 million delinquent loan it previously had guaranteed for Mhangura.

Gold.—Ashanti produced a record 3,368 kilograms (kg) of gold at the Freda Rebecca Mine in 1998 from 1.11 million metric tons of ore. Ore production from the depleted Freda open pit ended in February after which all ore production was from underground (Ashanti Goldfields Co. Ltd, January 27, 1999, Ashanti announces strong production and cost reductions for 1998, accessed May 19, 1999, at URL <http://www.ashanti.co.gh/pressreleases/current/seann170.htm>). Battlefield Minerals Corp. of Canada was building a carbon-in-pulp treatment plant at the Pickstone-Peerless gold mine. Casmyn Corp. of the United States added a fourth production circuit at the open pit Turk Mine, increasing output capacity to 650 kilograms per year (kg/yr) of gold, and began ore production from the Queens Group of mines (Casmyn Corporation, August 26, 1998, Casmyn Corp. announces third quarter results, accessed August 27, 1998, at URL http://biz.yahoo.com/prnews/980826/nv_casmyn_1.html).

Falcon Gold Zimbabwe Ltd. (Falgold), a subsidiary of Falcon Investments S.A. of Luxembourg, closed the Dalny and the Venice Mines in 1998 and continued operations at the Golden Quarry Mine. Bayham Mining Ltd. of Zimbabwe acquired the option to buy the assets of Falgold's closed mines. At the Blanket Mine, Kinross Gold produced 1,097 kg of gold (Kinross Gold Corp., January 26, 1999, press release, accessed July 16, 1999, at URL <http://www2.cdn-news.com/scripts/ccn-release.pl?1999/01/26/k990126>). Lonrho's subsidiaries, Independence Mining (Pvt.) Ltd. and Corsyn Consolidated Mines (Pvt.) Ltd., continued to restructure the group's mining activities. Independence Mining successfully completed a 9-month, \$1.3 million clean up of the Umzingwane River after the February 1998 slimes dam breach.

Kwe Kwe Consolidated Gold Mines Ltd., a subsidiary of Delta Gold Zimbabwe (Pvt.) Ltd., commissioned the Chaka gold mine near Kwekwe. Trial mining at Chaka had resulted in the production of 70 kg of gold during the last quarter of 1998. In August 1998, Delta Gold began construction of a \$23 million mine on the Eureka prospect, near Guruve. The proposed 2,000-kg/yr-capacity Eureka gold mine was expected to be on-stream in 1999 (Delta Gold Zimbabwe (Pvt.) Ltd., 1998).

Sabi Gold Mines Ltd., a subsidiary of ZMDC, was continuing its \$4 million expansion program at the Sabi Mine. Trillion Resources proposed to expand the production capacity of the Ndarama gold mine to 900 kg/yr (Trillion Resources Ltd., 1998).

Nickel.—The \$1.1 million shaft-deepening program continued at Bindura Nickel Corp. Ltd.'s Trojan Mine; however, declining nickel prices, poor ground conditions, and difficult ore mineralogy resulted in the closure of the Bindura's Epoch Mine in September. Environmental remediation of the mine site was underway. Bindura also temporarily shelved plans to open the proposed Hunter's Road Mine.

Bindura Smelting & Refinery Ltd. produced 8,732 t of nickel from ore from its mines in Zimbabwe. In 1998, toll refined nickel reached 10,579 t. RTZ's Empress Refinery produced 6,430 t of toll-refined nickel and Bindura toll refined 4,149 t of nickel, as toll-refined nickel exceeded nickel production from locally sourced concentrates (Bindura Nickel Corp. Ltd, 1999; TEX Report, 1999). Nickel matte imported from Botswana for toll refining at Bindura and RTZ was augmented by nickel

concentrates imported from Australia.

Platinum.—Delta Gold spun off its platinum interests in Zimbabwe to Zimbabwe Platinum Mines Ltd. (Zimplats). Delta Gold retained 51% equity interest in Zimplats and assigned the remaining 49% interest to Delta Gold shareholders. Technical problems continued to plague operations at the Hartley platinum complex of BHP Minerals Zimbabwe, a subsidiary of Broken Hill Proprietary Co. Ltd. of Australia, and Zimplats. An open pit mine was opened to supplement less-than-expected underground ore production, and the newly opened smelter was closed for 2 months for modifications (Africa Energy & Mining, 1998; Johnson Matthey, 1999, p. 19).

Anglo American Corp. completed a feasibility study on the Unki prospect near Shurugwi in March and continued negotiating tax concessions and expatriate work permits with the Government for the proposed \$60 million Unki platinum mine (Stanley Gain, Herald, January 17, 1999, Bureaucracy delays billion-dollar platinum project, accessed January 25, 1999, at URL <http://www.zimsurf.co.zw/theherald/jan99/17/beau.html>). In October 1998, the feasibility study of Zimplats' 100%-owned Ngezi platinum prospect was expanded to include the option of developing the prospect with an open pit mine.

Steel.—The reconstruction of Zimbabwe Iron and Steel Co. (Pvt.) Ltd.'s (Zisco) No. 4 blast furnace by China's Shougang International continued during 1998. Ferrostaal AG of Germany was rehabilitating Zisco's continuous casting facility. As part of the modernization program, Ferrostaal installed a dedusting system, worked on a water-treatment plant, and installed a basic oxygen furnace converter vessel.

Uranium.—In September, Minroc Mines Inc. of Canada acquired a 50% interest in the Kanyemba uranium-vanadium prospect from Cline Mining Corp. of Canada.

Industrial Minerals

Asbestos.—In May, African Associated Mines (Pvt.) Ltd. proposed a \$3 million mine and plant modernization. The Asian economic crisis had adversely affected its primary asbestos markets, although in 1998, new marketing agreements were signed with Iranian, Japanese, and South African distributors. The company finished the year fighting a proposed ban on the commercial use of chrysotile asbestos in the European Union and the United Kingdom.

Cement.—Portland Holdings Ltd. commissioned the \$30 million Colleen Bawn cement kiln in August, but startup problems effectively reduced the cement production (Financial Gazette, November 26, 1998, Shortage of cement hits construction sector hard, accessed November 30, 1998, at URL <http://www.africaonline.co.zw/fingaz/99/stage/archive/981126/companies2157.html>).

Diamond.—In February 1998, River Ranch (Pvt.) Ltd., the operating company of the River Ranch Diamond Mine, Zimbabwe's only formal diamond mine, closed the mine because of low international diamond prices. In November, Buby Minerals (Pvt.) Ltd. of Zimbabwe was appointed by the

liquidators to rehabilitate the mine equipment and process the diamond dump at the mine. Evaluation of the bids from five companies for the mine's assets were being evaluated by the receivers at yearend.

Mineral Fuels

Coal.—Wankie Colliery Co. (Pvt.) Ltd. was developing the \$167 million M-block Mine. The proposed 600,000-metric-ton-per-year-capacity underground mine will supplant coal output produced by Wankie's No. 3 Mine in 1998 (Mining Journal, 1998).

Petroleum.—In 1998, the continued financial problems of the state-owned fuel distribution company, National Oil Co. of Zimbabwe, resulted in several fuel shortages. The Ministry of Transport and Energy was evaluating the construction of an oil refinery in Zimbabwe to reduce the country's dependence of imported refined petroleum products. The country's old oil refinery, the Feruka, near Mutare, had been converted into a petroleum storage depot in 1981.

Infrastructure

Most of landlocked Zimbabwe's bulk commodities were moved by rail. National Railways of Zimbabwe (NRZ) announced a freight fare increase of 25% to 30% on all commodities in July (Zimbabwe Business News Headlines, July 27, 1998, item no. 14, accessed on July 28, 1998, at URL <http://www.bizafrica.com/zimbabwe/opport/daily.html>). All major cities and industrial centers were linked to Botswana, Mozambique, South Africa, and Zambia by the NRZ. Petroleum products were piped through Mozambique via the Beira pipeline to Feruka and then moved west via the Mutare-Harare pipeline or trucked on Zimbabwe's 85,784-km road network. Additional petroleum products were imported via railroad tanker cars through South Africa.

Outlook

Asbestos, coal, ferroalloys, gold, and nickel are expected to remain the mainstays of the Zimbabwean mineral economy, with the significance of granite and platinum-group-metals production expected to increase. The continued high cost of domestic capital, potential negative international perception of governmental actions, and costs associated with the widespread Human Immuno-Deficiency Virus/Acquired Immune Deficiency syndrome (HIV/AIDS) infection of the workforce (estimated to be 25% of the urban labor pool) could be detrimental to the industry (Nqobile Nyathi, September 3, 1998, AIDS forces companies to dig deeper into coffers, Financial

Gazette, accessed September 4, 1998, at URL <http://www.africaonline.co.zw/fingaz/stage/archive/980903/companies7995.html>). The investment regulations, the nation's well-developed and well-maintained infrastructure, new exploration techniques, and accessible mineral resources, however, were expected to encourage further local and foreign participation in the mineral industry.

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Major Sources of Information

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- Bartholomew, D.S., 1990, Base metal and industrial mineral deposits of Zimbabwe. Zimbabwe Geological Survey Mineral Resources Series No. 22, Harare, 154 p.
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TABLE I
ZIMBABWE: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997	1998
METALS					
Antimony, mine output, concentrate, Sb content	65	37	5	-- r/	--
Chromite, gross weight thousand tons	517	707	697	670 e/	605
Cobalt, metal 2/	126	109	106 r/ 3/	126 r/	137
Columbium and tantalum, tantalite concentrate, gross weight e/	7 3/	1	--	--	--
Copper:					
Mine output, concentrate, Cu content e/ thousand tons	9	9	10	9	4
Metal:					
Smelter output, blister/anode, primary e/	10,000	8,000	7,600	4,000	3,000
Refinery output, refined/cathode, primary	9,350	6,875	10,900	4,993 r/	2,941
Gold kilograms	20,512	23,959	24,699	24,156 r/	25,175
Iron and steel:					
Mine output, iron ore:					
Gross weight thousand tons	4	311	324	479	372
Fe content e/ do.	3	160	160	240	190
Metal:					
Pig iron e/ do.	100	209 3/	210	216 r/	230
Steel, crude do.	187	210	212	214 r/	220
Ferroalloys:					
Ferrochromium do.	183	254	243	233 r/	247
Ferrosilicon chromium do.	36	47	33	17 r/	21
Nickel:					
Mine output, concentrate, Ni content	13,836	11,721	11,561	12,963 r/	12,872
Refinery output, refined metal	13,516	10,864	9,694	10,300 r/ 4/	8,732
Platinum-group metals:					
Palladium kilograms	17	17 e/	120 e/	245 r/	1,855
Platinum do.	7	7 e/	100 e/	345 r/	2,730
Rhodium do.	-- e/	-- e/	-- e/	27	177
Selenium e/ do.	2,009	2,000 e/	2,000 e/	1,000 r/	500
Silver do.	10,942	15,640	9,982	5,923	6,681
Tin:					
Mine output, Sn content e/	100	10	10	10	1
Smelter output, metal	82	--	--	--	--
INDUSTRIAL MINERALS					
Asbestos thousand tons	152	169	165	145	123
Barite	--	--	-- e/	1,217 r/	1,844
Cement, hydraulic e/ thousand tons	1,070	968 r/	1,000 r/	1,100 r/	1,100
Clays:					
Bentonite (montmorillonite)	169,097	169,823	185,953	186,000 e/	135,785
Kaolin	462	57	-- e/	-- e/	-- e/
Other clays 5/	13,997	12,743	14,479	14,000 e/	2,818
Diamond carats	173,588	204,416	437,266	421,307	28,732
Emerald kilograms	276	2,209	1,080	1,000 e/	19
Feldspar	1,617	3,920	3,248	2,254 r/	2,241
Graphite	7,890	11,381	7,691	12,779	13,806
Kyanite	567	875	141	1,113 r/	3,780
Lithium minerals, gross weight	25,279	33,498	30,929	49,833	28,055
Magnesite	1,588	5,597	10,659	13,050 r/	4,321
Mica	213	1,040	1,500	30 r/	1,309
Nitrogen, N content of ammonia e/	70,000	42,600 r/	61,400 r/	63,700 r/	56,500
Phosphate rock, marketable concentrate thousand tons	151	154	123	94 r/	91
Pigments, iron oxide	438	400	400 e/	-- r/ e/	--
Stone, sand and gravel:					
Granite	106,605	121,685	109,268	109,903 r/	125,576
Limestone thousand tons	1,658	1,499	1,425	1,027 r/	1,473
Quartz 6/ do.	131	172	96	52 r/	10
Sulfur					
Pyrite:					
Gross weight	71,026	70,706	59,831	48,101	52,908
S content e/	31,000	31,000	26,000	26,000 r/	28,000
Byproduct acid, metallurgical and coal process gas e/	4,500	4,500	5,000	5,000	2,500
Talc	2,049	2,080	1,076	1,023 r/	1,039
Vermiculite	8,184	13,742	10,249	14,841 r/	14,804

See footnotes at end of table.

TABLE 1--Continued
ZIMBABWE: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997	1998
MINERAL FUELS AND RELATED MATERIALS					
Coal, bituminous	5,515	5,538	5,175	4,750 r/	4,575
Coke, metallurgical e/	550	300	600	600	600

e/ Estimated. r/ Revised.

1/ Table includes data available through January 1, 2000.

2/ "Metal" includes metal content of compounds/salts and may include cobalt recovered from nickel-copper matte imported for toll refining.

3/ Reported figure.

4/ Excludes toll-refined nickel.

5/ Includes fire clay.

6/ Includes rough and ground quartz, as well as silica sand.

TABLE 2
ZIMBABWE: STRUCTURE OF THE MINERAL INDUSTRY IN 1998

(Thousand metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
Asbestos		African Associated Mines (Pvt.) Ltd. [SMM Holdings (Pvt.) Ltd., 100%]	Shabanie Mine, Zvishavane; Gaths and King Mines, Mashava	300
Chromite, gross weight		Zimbabwe Mining and Smelting Co. (Pvt.) Ltd. (Zimasco) (Zimasco Consolidated Enterprises, 100%)	Peak Mine and Railway Block Mine at Shurugwi and mines at Mutorshanga and Lalapanzi	500
Do.		Zimbabwe Alloys Ltd. (Zimalloys) (Anglo American Corp. of South Africa Ltd., 100%)	Great Dyke Mine, Mutoroshanga; Netherburn Mine at Lalapanzi; and Inyala Mine at Mberengwa	50
Do.		Local cooperatives	North Dyke	50
Coal		Wankie Colliery Co. (Pvt.) Ltd. (private investors, 60%; Government, 40%)	Hwange	5,500
Cobalt	tons	Bindura Nickel Corp. Ltd. (Anglo American Corp. of South Africa Ltd., 65%; Government, 20%)	Shangani Mine, northwest of Shangani; Madziwa Mine, 50 kilometers northeast of Bindura; Trojan Mine, Bindura; Epoch Mine, Filabusi 1/	150
Copper		Mhangura Copper Mines Ltd. (Zimbabwe Mining Development Corp., 55%)	Mhangura	16
Do.		Munyati Mining Ltd. Co. (Reunion Mining PLC, 75%; Zimbabwe Mining Development Corp., 25%)	Sanyati Mine, Sanyati	5
Do.		Bindura Smelter & Refinery Ltd. (Bindura Nickel Corp. Ltd., 100%)	Solvent extraction-electrowinning plant at Bindura	2 2/
Do.		Rio Tinto Zimbabwe Ltd.	Solvent extraction-electrowinning plant at Eiffel Flats	6
Do.		Lomagundi Smelting & Mining (Pvt.) Ltd. (Merits Ltd., 100%)	Smelter at Alaska	35
Do.		do.	Refinery at Alaska	28
Diamond	carats	Auridam Zimbabwe (Pvt.) Ltd. (Auridam Consolidated NL, 50%; Redaurum Red Lake Mines Ltd., 50%)	River Ranch Mine, near Beitbridge 1/	440,000
Gold	kilograms	Independence Mining (Pvt.) Ltd. (Lonrho PLC, 100%)	How Mine, Bulawayo; Tiger Reef Mine, Kwekwe; Redwing Mine, Penhalonga; Shamva Mine, Shamva; Legion dump, Kezi	3,000
Do.	do.	Ashanti Goldfields Zimbabwe (Pvt.) Ltd. (Ashanti Goldfields Co. Ltd., 82.4%, private investors, 17.6%)	Freda Rebecca Mine, Bindura	3,300
Do.	do.	Rio Tinto Zimbabwe Ltd. (RTZ Corp. PLC, 56%)	Renco Mine, 75 kilometers southeast of Masvingo; Patchway Mine, Kadoma; and Cam and Motor dump, Kadoma	2,800
Do.	do.	Falcon Gold Zimbabwe Ltd. (Falcon Investments S.A., 71.7%)	Dalny Mine, Chegutu; 1/ Venice Mine, Kadoma; 1/ Golden Quarry Mine, Shurugwi; Old Nic Mine, Bulawayo 1/	2,000
Do.	do.	Corsyn Consolidated Mines (Pvt.) Ltd. (Lonrho PLC, 100%)	Anzac Mine, Kwekwe; Arcturus Mine, Arcturus; Mazowe Mine, Mazowe; Muriel Mine, Mutorashanga	1,700
Do.	do.	Kinross Gold Corp.	Blanket Mine	1,100
Do.	do.	Zimbabwe Mining Development Corp. (Government, 100%)	Lexington Mine and Elvington Gold Mine, near Chegutu	1,000
Do.	do.	Anglo American Zimbabwe (Anglo American Corp. of South Africa Ltd.)	Bubi Mine	900
Do.	do.	Connemara joint venture (First Quantum Minerals Ltd., 95%; Chase Minerals (Pvt.), 5%)	Connemara Mine, north of Gweru	600
Do.	do.	Casmyn Mining Zimbabwe (Pvt.) Ltd.	Turk Mine, north of Bulawayo; Queens group of mines	650
Do.	do.	Jena Mines (Pvt.) Ltd. [Zimbabwe Mining Development Corp., 50%; Trillion Resources (Pvt.) Ltd. Zimbabwe, 50%]	Jena Group, Kwekwe area	400
Iron and steel:				
Crude steel		Zimbabwe Iron and Steel Co. (Pvt.) Ltd. (Government, 89%)	Redcliff, near Gweru	240 3/
Iron ore, gross weight		Buchwa Iron Mining Co. [Zimbabwe Iron and Steel Co. (Pvt.) Ltd., 100%]	Buchwa West Mine, Buchwa; Ripple Creek Mine, near Redcliff	1,400
Ferroalloys:				
Ferrochromium, high-carbon		Zimbabwe Mining and Smelting Co. (Pvt.) Ltd. (Zimasco) (Zimasco Consolidated Enterprises, 73%)	Smelter at Kwekwe	220
Ferrochromium, low-carbon		Zimbabwe Alloys Ltd. (Zimalloys) (Anglo American Corp., 100%)	Smelter at Gweru	40
Ferrochromium-silicon		do.	do.	55

See footnotes at end of table.

TABLE 2--Continued
ZIMBABWE: STRUCTURE OF THE MINERAL INDUSTRY IN 1998

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Lithium	Bikita Minerals (Pvt.) Ltd. (private, 100%)	Bikita Mine, 60 kilometers east of Masvingo	33
Nickel	Trojan Nickel Mines Ltd. (Bindura Nickel Corp. Ltd., 100%)	Shangani, Madziwa, Trojan, and Epoch Mines 4/	13
Do.	Bindura Smelter & Refinery Ltd. (Bindura Nickel Corp. Ltd., 100%)	Smelter and refinery at Bindura	14
Do.	Rio Tinto Zimbabwe Ltd.	Empress Nickel Refinery, Eiffel Flats, northeast of Kadoma	9
Platinum-group metals kilograms	Joint venture of BHP Minerals Zimbabwe (66.6%) and Zimbabwe Platinum Mines Ltd. (33.3%)	Hartley Mine, Selous	4,000
Do.	do. Zimbabwe Mining and Smelting Co. (Pvt.) Ltd. (Zimasco) (Zimasco Consolidated Enterprises, 100%)	Mimosa Mines, east of Zvishavane	600
Phosphate	Dorowa Minerals (Pvt.) Ltd. (Chemplex Corp. Ltd., 100%)	Dorowa Mine, 90 kilometers west of Mutare	155
Vermiculite	Shawa Vermiculite (Pvt.) Ltd. (private, 100%)	Shawa Mine, near Dorowa	39
Do.	Dinidza Vermiculite Mining Co. (Pvt.) Ltd. (private, 100%)	Dinidza Mine, near Dorowa	10

1/ Closed in 1998.

2/ Copper cathode production was suspended in 1998.

3/ Blast furnace No. 4 (capacity: 780,000 metric tons per year) was undergoing rehabilitation and remained shut in 1998.

4/ Epoch Mine was closed in September 1998.

THE MINERAL INDUSTRIES OF THE MIDDLE EAST

By Bernadette Michalski¹ and Philip M. Mobbs

For many of the 15 nations of the Middle East covered in this section, petroleum continued to be the most important mineral commodity in 1998. Petroleum production and processing remained, for the most part, under Government control.

In 1998, the depressed international market price for petroleum was aggravated by weak demand for petroleum in Asian markets. The continued drop of oil and gas prices and the resultant decreased revenues encouraged some countries to increase production to maintain income streams. In March, Saudi Arabia negotiated a production-restraint agreement with other petroleum-exporting countries. This agreement resulted in decreased oil production for many of the oil-producing nations of the Middle East during the second half of the year.

In 1998, Saudi Arabia once again became the leading supplier of crude oil to the United States. At 512 million barrels (Mbbbl), Saudi Arabia surpassed Venezuela (502 Mbbbl) and Mexico (482 Mbbbl). Iraq (123 Mbbbl) jumped to eighth place on the list of the largest crude oil suppliers to the United States, and Kuwait (110 Mbbbl) remained ninth.

Two Middle Eastern countries were considered to be significant sources of nonfuel minerals for the U.S. industry—Israel for gemstones and Turkey for ferrochromium and pumice.

In 1998, mineral exploration activity included the hunt for copper and gold in Cyprus, Saudi Arabia, and Turkey; gold exploration in Iran; and prospecting for base and precious metals in Yemen. Hydrocarbon exploration continued in Iran, Israel, Jordan, Oman, Saudi Arabia, Syria, Turkey, the United Arab Emirates, and Yemen. New oilfields came on-stream in Iraq, Turkey, Saudi Arabia, and Yemen.

In Bahrain, Aluminium Bahrain BSC completed the expansion of the Number 3 line, expanding the smelter's capacity to 496,500 metric tons per year (t/yr). Bahrain Petroleum Co. initiated an upgrade of the petroleum refinery, and Gulf Petrochemical Industries Co. opened a 1,700-metric-ton-per-day-capacity urea plant.

In Cyprus, Hellenic Copper Mines Ltd.'s solvent extraction and electrowinning plant at the Skouriotissa copper mine reached its full production capacity of 8,000 t/yr.

In Iran, a new mining law came into effect in June 1998. Construction projects in Iran included an alumina refinery at Jajarm, an 80,000-t/yr-capacity copper smelter in Khatounabad, and a 27,000-t/yr-capacity zinc smelter near Yazd. The U.S. Government waived the imposition of sanctions against the international consortium developing the offshore South Pars Gasfield. Subsequently, the National Iranian Oil Co. offered international companies the opportunity to participate in 42 oil and gas sector projects.

In Iraq, South Oil Co. of Iraq brought the West Qurna Oilfield on-stream. In February 1998, the United Nations (U.N.) Security Council authorized an increase in Iraq's petroleum export ceiling to \$5.25 billion during the 6-month period beginning with the fourth phase of the oil-for-food program that began in June 1998. U.N. Resolution 986 had initially authorized a \$2 billion ceiling for each 6-month phase of the program. About one-half of Iraq's oil exports were piped from Kirkuk to the Ceyhan oil terminal in Turkey; much of the remainder was shipped via the Iraqi port of Mina al-Bakir on the Arabian Gulf.

In Qatar, the Qatar Steel Co., Ltd., produced a record volume of crude steel.

In Saudi Arabia, construction of Saudi Iron and Steel Co.'s (Hadeed) flat steel rolling mill continued. Hadeed also was testing a new HYL-process direct-reduced iron plant at Al-Jubayl. A 1.2-million-metric-ton-per-year-capacity cement plant was commissioned at Tabuk. Low mineral commodity prices resulted in the deferment of a number of fertilizer, petroleum, and petrochemical projects in the Kingdom, as well as delaying the development of the Al-Masane polymetallic prospect.

Tüprag Metal Madencilik San. Ve Tic. Sti. began obtaining permits for the Efemçukuru gold project in Turkey. In 1998, the aluminum, boron, copper, chromite, ferrochrome, and silver operations of state-owned Etibank Genel Müdürlüğü were spun off as separate companies within the newly formed state-owned Eti Holding Group.

¹Deceased.

TABLE 1
MIDDLE EAST: PRODUCTION OF SELECTED MINERAL COMMODITIES, 1998 1/ 2/

(Thousand metric tons unless otherwise specified)

Country	Alumi- num e/	Boron	Cement, hydraulic e/	Chromite	Copper, mine Cu content	Gypsum e/	Natural gas	
							Plant liquids (thousand 42-gallon barrels)	Dry (million cubic meters)
Bahrain	499 3/	--	172	--	--	--	3,960	8,030
Cyprus	--	--	1,200	--	5	270	--	--
Iran	88	(4/) e/	19,000	170 5/	115	9,750	22,000	45,000
Iraq	--	--	2,000	--	--	--	8,000	4,000
Israel	--	--	5,100	--	--	60	--	20
Jordan	--	--	1,386	--	--	176	--	264
Kuwait	--	--	2,000	--	--	--	45,000	9,260
Lebanon	--	--	4,100	--	--	3	--	--
Oman	--	--	1,300	18	--	--	4,000	7,800
Qatar	--	--	700	--	--	--	22,000	21,500
Saudi Arabia	--	--	14,000	--	1 e/	330	263,900	46,100
Syria	--	--	4,500	--	--	300	2,500	5,900
Turkey	60	1,650	38,200 3/	1,404	40 e/	352	--	562
United Arab Emirates	400	--	6,000	60 e/	--	90	110,000	37,000
Yemen	--	--	1,207	--	--	102	2,600	10,000
Total, Middle East 6/	1,047	1,650	100,865	1,652	161	11,433	483,960	195,436
Total, world	22,100	4,370	1,523,000	12,700	12,200	107,000	2,156,400	2,349,200
Share of world total	5%	38%	7%	13%	1%	11%	22%	8%
United States	3,713	1,170	85,222	--	1,860	19,000	642,035	534,060

Country	Nitrogen, N in ammonia e/	Petroleum, crude (thousand 42-gallon barrels) 7/	Phosphate rock e/ (gross weight)	Potash e/ K ₂ O equivalent	Salt e/	Steel, crude e/	Sulfur e/
Bahrain	336	14,160	--	--	--	--	67
Cyprus	--	--	--	--	--	--	--
Iran	1,034	1,325	--	--	1,450	5,600	900
Iraq	450	750,000	1,000 8/	--	250	200	450
Israel	55	36	4,050 8/	1,500	800	203	60
Jordan	--	--	5,817	910	195	30	--
Kuwait	430	761,025	--	--	100	--	665
Lebanon	--	--	--	--	4	--	--
Oman	--	328,500	--	--	--	--	30
Qatar	579	254,040	--	--	--	646	65
Saudi Arabia	1,400	3,041,000	--	--	90	2,400	2,300
Syria	129	202	2,496	--	163	70	10
Turkey	560	23	--	--	2,170 3/	13,351 3/	350
United Arab Emirates	370	880,000	--	--	--	--	237
Yemen	--	138,600	--	--	147	--	--
Total, Middle East 6/	5,007	6,168,911	13,363	2,410	5,369	22,500	5,134
Total, world	105,700	27,430,100	145,000	25,000	192,000	781,000	57,700
Share of world total	5%	22%	9%	10%	3%	3%	9%
United States	14,700 9/	2,656,500	45,100	1,300	41,300	98,600	11,600

e/ Estimated.

1/ Table includes data available through April 27, 2000.

2/ Data may be different from that appearing in individual country production tables owing to availability of more-current data.

3/ Reported figure.

4/ Less than 1/2 unit.

5/ Concentrate.

6/ May not add to totals shown because of independent rounding.

7/ Includes lease condensate.

8/ Beneficiated.

9/ Synthetic anhydrous ammonia; excludes coke oven byproduct ammonia.

THE MINERAL INDUSTRY OF

BAHRAIN

By Bernadette Michalski¹

In 1998, the mineral industry supplied about 90% of Government revenues and export earnings. Crude oil from Awali Field, the only oilfield in Bahrain, was supplemented by production from the offshore Abu Saafa Field in the territorial waters of Bahrain and Saudi Arabia. Natural gas, principally from the Khuff reservoir, was available for low-cost electric power generation to sustain the nation's aluminum smelting and fabrication industries. Other mineral value-added products included ammonia, cement, iron ore pellets, methanol, natural gas liquids, and petroleum refined products.

The oil sector accounted for 60% of export revenues. In 1997, the latest year for which trade data is available, the country exported 260,000 barrels per day (bbl/d) of petroleum products and a minor amount of crude oil, which earned a total of \$3.15 billion.

Aluminium Bahrain B.S.C.'s (ALBA) smelter capacity was expanded to 496,500 metric tons per year (t/yr) in 1997. Expansion of cell line No. 3 had not been fully completed until early 1998 (Metal Bulletin, 1998). Alumina feedstock was imported principally from Australia. ALBA's development plans included construction of a 450,000-t/yr coke calcination plant to come on-stream in 2001, replacing imports of calcined coke from Argentina and the United States. ALBA will import 585,000 t/yr of green coke for feedstock. When the plant is operating at full capacity, about 200,000 t/yr of calcined coke will be available for export. The expansion project included the construction of a desalination plant with a capacity of 41,800 cubic meters per day. In November, ALBA awarded a \$7.4 million consultancy contract for reclamation of 141,000 square meters of land at ALBA's marine terminal, 10 kilometers northeast of the aluminum smelter. The \$400 million project will be financed by six banks led by Chase Manhattan. Other construction projects include a 100,000-metric-ton (t) aluminum storage facility, a new jetty to accommodate ships up to 80,000 deadweight tons, construction of loading and unloading facilities for green coke and raw materials used to produce calcined coke, and construction of a 5,000-t calcined coke storage facility to be linked with the existing smelter (Middle East Economic Digest, 1998b).

The Gulf Industrial Investment Company (GIIC) owned and operated a 4-million-metric-ton-per-year (Mt/yr)-capacity iron ore pelletizing plant at Al Hidd. Iron ore feedstock was imported from Brazil, India, and possibly Iran. The Nippon Denro Ipsat Group of India completed a feasibility study for the construction of a \$290 million, 1.2-Mt/yr-capacity sponge iron plant at the site. The Ipsat Group will supply \$64 million in equity for the project. Additionally, Mitsui & Company of Japan, having acquired a 20% equity in the project, will

contribute \$16 million, with the remainder to be supplied by regional and international financial markets.

In February 1998, Chevron Corporation of the United States obtained an exploration agreement for three offshore blocs north and west of the island covering a total of 5,900 square kilometers. Chevron conducted two- and three-dimensional surveys in 1998. Exploratory drilling was scheduled for 2000. This represented the first active petroleum exploration work in Bahrain by a foreign entity since the mid-1980's.

Natural gas production stabilized at about 28 million cubic meters per day (Mm³/d). About 80% of the gas was derived from nonassociated gas reservoirs; the remainder was associated gas from Al Awali crude oil production. Nearly 50% of the dry natural gas production was consumed by ALBA, followed closely by gas reinjection requirements at Al Awali Field; the remainder was consumed in electric power generation.

Crude oil production was derived from Al Awali where a series of workovers and gas-injection programs have helped stabilize production levels at between 14 million and 15 million barrels per year (Mbbbl/yr) since 1984. Output was considerably below peak levels of 28 Mbbbl/yr in the 1970's.

Caltex Petroleum Corporation sold its 40% equity in the Bahrain Petroleum Co. (BAPCO) to the Government of Bahrain in 1997. In 1998, the Bahrain Government refined and marketed 100% of petroleum products instead of 60%. Although the equity ownership interest was altered, Caltex remained as the supplier of the technical services to the refinery and continued in partnership with the Government in the airport refueling and natural gas ventures. Caltex remained actively involved as a major lubricants marketer, as well as continuing to provide refined product storage in Sita.

BAPCO launched a \$500 million upgrade of its 250,000-bbl/d refinery. The upgrade will reduce the sulfur content in the diesel to 0.05% from 0.75% to 1%. The project was being implemented to meet the requirements of BAPCO's main market, India, where sulfur tolerance was 0.25% maximum. United States licensors were spearheading the upgrade. A 70,000-bbl/d diesel hydrotreater and pressure swing absorption unit will be licensed by Universal Oil Products. The 18-Mm³/d hydrogen plant will be licensed by Kinetics Technology International. Two new 200-metric-ton-per-day (t/d) sulfur plants will be licensed by TPA Inc. The licensor for the upgrade of the existing midhydrocracker was Mobil, Akzo, Kellogg (MAK). The MAK technology should allow a 10% increase in conversion (Middle East Economic Digest, 1998a).

Gulf Petrochemical Industries Company, a joint Bahraini-Kuwait venture, opened a \$180 million, 1,700-t/d-capacity urea plant in January 1998, raising the company's capacity to 4,100

¹Deceased.

t/d of methanol, urea, and ammonia. More than 98% of the output was exported to Australia, Canada, China, and Southeast Asia.

Bahrain's crude oil reserves were 210 million barrels, and natural gas reserves were 142 billion cubic meters (Arab Petroleum Research Center, 1998, p. 59-76).

The Asian economic crisis seriously affected the nation's oil and aluminum export revenues as prices of both commodities have fallen. Nevertheless, plans for ALBA's coke calcination plant and other ancillary projects, as well as GIIC's sponge iron plant, have not been altered because most of the financing for these projects will be obtained from the Arab and the Islamic Development Funds and commercial banks.

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 Middle East Economic Digest, 1998a, Technology licensors picked for Bapco sulphur work: Middle East Economic Digest, v.42, no. 46, November 13, p. 14.
 ———1998b, Work starts on ALBA coke plant: Middle East Economic Digest, v. 42, no. 49, November 20, p. 8.

Major Sources of Information

Ministry of Oil and Industry
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 Manama, Bahrain
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 Fax: (973) 293 007

Bahrain National Oil Co. (BANOCO)

P.O. Box 25504
 Awali, Bahrain
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 Fax: (973) 753203

Bahrain Petroleum Co. (BAPCO)

Bahrain Refinery
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 Manama, Bahrain
 Telephone: (973) 754 444
 Fax: (973) 752 924

Bahrain National Gas Co. B.S.C. (BANAGAS)

P.O. Box 29099
 Rifaa, Bahrain
 Telephone: (973) 756 222
 Fax: (973) 756 991

Aluminium Bahrain B.S.C. (ALBA)

P.O. Box 570
 Manama, Bahrain
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 Fax: (973) 830 083

TABLE 1
 BAHRAIN: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997	1998 e/
Aluminum, smelter output, primary metal	447,000	450,709	461,245	489,847	499,000 2/
Cement	225,000 e/	196,568	192,000	171,854	172,000
Gas, natural:					
Gross million cubic meters	9,946	12,538	10,210	10,500 e/	10,500
Dry do.	7,091	7,205	6,950 e/	8,030	8,030
Methanol	419,322	427,350	384,558	447,969	450,000
Natural gas plant liquids:					
Propane thousand 42-gallon barrels	1,455	1,375	1,272	1,213	1,210
Butane do.	1,190	1,163	1,087	1,048	1,050
Naphtha do.	1,863	1,848	1,784	1,716	1,700
Nitrogen, N content of ammonia	337,506	357,504	322,500 r/	355,900 r/	335,900 2/
Petroleum:					
Crude thousand 42-gallon barrels	14,695	14,468	14,124	14,159	14,160
Refinery products:					
Gasoline do.	7,704	7,766	8,139	7,377	7,400
Jet fuel do.	7,106	6,219	6,450 e/	6,300 e/	6,300
Kerosene do.	10,409	11,327	11,600 e/	11,200 e/	11,200
Distillate fuel oil do.	28,852	31,027	21,407	19,188	19,200
Residual fuel oil do.	20,896	20,807	30,430	33,000 e/	33,000
Other do.	13,630	14,728	16,800 e/	14,310 e/	14,300
Total do.	88,597	91,874	94,826	91,375	91,400
Sulfur	52,312	55,390	74,282	66,334	66,500

e/ Estimated. r/ Revised.

1/ Table includes data available through April 1, 1999.

2/ Reported figure.

THE MINERAL INDUSTRY OF CYPRUS

By Bernadette Michalski¹

The nation's mineral industry was dominated by copper and, to a lesser extent, an extensive range of nonmetallic minerals. About 250 quarries were in operation producing such materials as aggregates, building stone, clay, crushed limestone, gypsum, and sand and gravel for local use and bentonite, gypsum, ochre, and umber for export. The value of mining and quarrying products in 1998 was approximately \$130 million,² more than two-thirds of which was attributed to the copper operations and the hydraulic cement industry. (See table 1.)

Cyprus' main trading partner was the European Union, accounting for about 49% of all imports and 29% of all exports (Central Bank of Cyprus, Cyprus in brief—The economy, accessed on July 10, 1998, at URL <http://www.centralbank.gov.cy/cyprus/the-econ.html>).

The Mines Service of the Ministry of Agriculture Natural Resources and Environment administers mineral operations under the Mines and Quarries (Regulation) Law, Chapter 270, 1959; the Mines and Quarries Regulations, 1958-79; the Petroleum (Production) Law, 1974; and the Cyprus Standard and Control of Quality Law, 1975. Mining operations in Cyprus have been owned and operated privately under leases and licenses issued by the Mines Service since 1958. Royalties on extracted mineral commodities ranged from 1% to 5%. The Economic Geology Section of the Geological Survey Department is responsible for mineral exploration programs and the evaluation of the country's resources. The Environmental Service is responsible for coordinating the environmental efforts of the Government departments.

In response to growing requirements for tourist facilities and infrastructure development, Cyprus Cement Co. Ltd. was formed in the mid-1950's, followed in the mid-1960's by the Vassiliko Cement Co. Ltd., a subsidiary of the Hellenic Mining Co. Vassiliko Cement Co. Ltd. captured 63% of the domestic market and exports to Egypt, Israel, Lebanon, and Syria. The company's export loading facilities can accept bulk tankers of up to 18.6 meters draft. Loading capacity ranges from 4,000 to 6,000 metric tons per day.

The Hellenic Copper Mines Ltd. (Hellenic Mining Co., 44%; Oxiana Resources NL of Australia, 43.7%; Mid-East Mining,

5%; Sterina Kimatiki, 4.15%; and the Hellenic Bank, 3.15%) was conducting a solvent extraction and electrowinning project at the Skouriotissa copper mine. Capacity level of 8,000 metric tons per year (t/yr) of 99.999% copper cathode was attained in 1998. Virtually all production was exported. Ore reserves at the Skouriotissa Mine's Phoenix deposit were initially calculated to be 9.2 million metric tons (Mt) of ore averaging 0.78% copper and 6 Mt averaging 0.31% copper. Succeeding exploration efforts have suggested a doubling of the initial reserve estimate and prompted the company to consider increasing output to 10,000 t/yr of cathode. A feasibility study for expansion to 20,000 t/yr was also under consideration (Mining Journal, 1998b).

The Hellenic Mining Co. of Cyprus formed a joint venture with Oxiana Resources NL of Australia to explore for base and precious metals in Cyprus. The agreement secured access for Oxiana to priority targets in historic copper and gold mining areas of Cyprus. Three gold prospects—Aleostos, Red Hill, and Tourounja—have outcropping alteration and mineralization typical of epithermal gold systems. The prospects are slated for drill testing (Mining Journal, 1998a).

Three specialized oil terminals—Larnaca, Dhekelia, and Moni—served the nation's energy trade.

The Cyprus Petroleum Refinery, Ltd., planned to build an isomerization unit to produce about 250,000 barrels per year of unleaded gasoline at its Larnaca refinery by the end of 1999. The refinery used Iraqi Kirkuk crude, which was blended with Russia's Urals light to compensate for its high-sulfur content. The new unit will replace current imports from Israel and Greece.

References Cited

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———1998b, Cyprus: Mining Journal [London] Special Supplement, v. 330, no. 8485, June 19, p. 28.

Major Source of Information

Mines Service

Ministry of Agriculture, Natural Resources and Environment
Nicosia, Cyprus

¹Deceased.

²Where necessary, values have been converted from Cypriot pounds (£) to U.S. dollars at the rate of £0.49=US\$1.00. Unless specifically stated, all data in this chapter are for the southern Greek-administered area because data related to the Turkish Cypriot area are sparse or unavailable.

TABLE 1
CYPRUS: PRODUCTION OF MINERAL COMMODITIES 1/ 2/

(Thousand metric tons unless otherwise specified)

Commodity		1994	1995	1996	1997 e/	1998 e/
METALS						
Copper cathode 3/	metric tons	--	--	1,499	4,435 4/	4,920 4/
INDUSTRIAL MINERALS						
Cement, hydraulic		1,044	1,021	1,000	910 r/	1,200
Clays:						
Bentonite	metric tons	50,441	71,773	70,927	101,000 r/	140,000 4/
Other:						
For brick and tile manufacture		475	407	400 e/	350	380
For cement manufacture e/		375	350	350	340 r/	370 4/
Total		850	757	750	690	750
Gypsum:						
Crude	metric tons	180,000	133,208	150,468	222,000	270,000 4/
Calcined	do.	4,000	4,000 e/	4,000 e/	4,000	4,000
Lime, hydrated	do.	5,525	5,530	6,000 r/ e/	6,000 r/	5,500 4/
Stone, sand, and gravel:						
Limestone, crushed (Havara)		3,000 e/	3,200	3,000 e/	3,000	3,000
Marble e/		25 r/	25 r/	25 r/	20 4/	8 4/
Marl, for cement production		1,600	2,000	1,600 e/	1,500	1,900 4/
Sand and gravel e/ 5/		6,000	6,000	6,000	6,500	7,600
Building stone		1,436	974	800	690 r/	100 4/
Umber	metric tons	9,000 e/	5,415	4,604	6,000 r/	5,000
MINERAL FUELS AND RELATED MATERIALS						
Petroleum refinery products:						
Liquefied petroleum gases	thousand 42-gallon barrels	350	375	375 e/	375	375
Gasoline	do.	900	900	900 e/	900	900
Kerosene and jet fuel e/	do.	400	400	400	400	400
Distillate fuel oil	do.	2,450	2,300	2,300 e/	2,300	2,300
Residual fuel oil	do.	2,500 e/	2,500	2,500 e/	2,500	2,500
Other	do.	200 e/	300	300 e/	300	300
Total	do.	6,800	6,775	6,775 e/	6,775	6,775

e/ Estimated. r/ Revised.

1/ Table includes data available through May 15, 1999.

2/ Mineral production data from the northern Turkish-occupied section of the country are not included in this table because available information is inadequate to make reliable estimates of output levels.

3/ Hellenic Mining Co. ceased copper cementation operations from Skouriotissa Mine talings in 1993. Activity resumed in July 1996 when a solvent extraction-electrowinning plant, designed to produce 8,000 metric tons per year was commissioned.

4/ Reported figure.

5/ Includes crushed aggregate.

THE MINERAL INDUSTRY OF

IRAN

By Philip M. Mobbs and Bernadette Michalski¹

Iran remained the world's fourth largest producer of crude oil, averaging about 3.63 million barrels per day (Mbbbl/d) in 1998. Petroleum continued to provide the bulk of this Middle Eastern nation's foreign exchange despite the 35% drop in Iranian crude oil prices during 1998 that followed a 32% decline in crude oil prices during 1997. The loss of projected revenue required serious Government budget revisions and focused the nation on the need for a more diversified economy; Iran has the potential for a significantly diversified mineral industry. Commercial production of mineral and metal commodities included aluminum, cement, chromite, copper, fertilizers, gypsum, iron, lead, petrochemicals, steel, stone, and zinc.

Although inflation was high, it dropped to 14.5% in 1998 compared with 17.3% in 1997 and about 50% in 1995. High foreign debt obligations restricted the availability of foreign exchange for imports and other Government spending. The gross domestic product of this country of about 62 million people was estimated to be \$100.3 billion in 1998, down from \$102.0 billion in 1997 (World Bank, September 22, 1999, Iran—Islamic Rep. at a glance, accessed October 25, 1999, via URL <http://www.worldbank.org/data/countrydata/countrydata.html>).

Government Policies and Programs

In 1995, Conoco Inc. of the United States had been forced to divest its interest in the contract to develop the offshore Sirri A and E structures under a March 14, 1995, U.S. Presidential Executive order banning U.S. companies from undertaking oil development projects in Iran (Brower, 1998). In 1996, the U.S. Government enacted the Iran-Libya Sanctions Act, proscribing any company (American or foreign) from exceeding a \$20 million per year investment or trading limit with Iran (Barry Schweid, Associated Press, U.S. examines Iran energy deal, accessed on March 3, 1999, at URL http://biz.yahoo.com/apf/990302/energy_dea_1.html). Threatened U.S. sanctions initially dampened international enthusiasm for mineral industry projects in Iran; however, in January 1998, the European Union lifted its ban on ministerial contacts with Iran, and European nations began to reestablish official relations (Middle East Economic Digest, 1998g). In March, National Iranian Oil Co. (NIOC) proposed to contract out about 100 oil and gas projects to international companies. In May, the U.S. Government waived sanctions against the international consortium developing the offshore South Pars gasfield (Middle East Economic Digest, 1998e). The waiver encouraged non-U.S. oil companies to reevaluate their interest in the proposed Iranian oil and gas opportunities.

For several years, the Government has been privatizing state-run mineral enterprises, primarily the smaller operations. In July 1998, the NIOC offered contracts on 42 oil and gas sector projects to international companies. Ventures included onshore and offshore exploration, oilfield and gasfield development, redevelopment of war-damaged fields, and secondary and tertiary recovery work, as well as work on natural gas liquids plants, natural gas pipelines, and upgrading oil refineries. Although Iran has offered foreign companies limited opportunities to engage in offshore projects since 1988, this scheme opened the onshore to international companies for the first time since the 1979 Iranian revolution (Middle East Economic Digest, 1998d; Tippee, 1998).

These proposed contacts were based on a "buy-back" scheme under which the contract winners would develop the project for a contract-specified rate of return for a specified period after recovering initial investment from the project's output. The Government tailored the buy-back contracts to conform with article 153 of the Iranian Constitution that prohibited foreign control over natural resources (Corzine, 1998; Corzine and Allen, 1998). The new mining law came into effect in June 1998.

Trade

Petroleum supplied more than 80% of hard currency revenues in the Iranian calendar year 1376 that ended on March 20, 1998. Revenue from oil and gas exports was about \$15.5 billion. (Middle East Economic Digest, 1998f). Other mineral exports have recently accounted for about 3% of export revenues (Iran News, August 22, 1999, Imports exceeded \$14b last year, accessed October 14, 1999, at URL <http://www.salamiran.org/Media/IranNews/990822.html>). In 1998, exporters of products other than petroleum were authorized to use their hard currency earnings to import essential goods. Previously, exporters were required to surrender foreign earnings at the official rate of 3,000 rials per U.S. dollar (Journal of Commerce, 1998).

Structure of the Mineral Industry

The overall management of the minerals sector is under the auspices of the Ministry of Mines and Metals. The Ministry's authority covers all mining, smelting, and refining industries except oil and gas, which are under the Ministry of Petroleum. The state owns the major companies in the minerals sector; however, the private sector controls most of the estimated 2,700 operating mines (Iran News, August 21, 1999, Iranian mining industry is privately run, Semnani, accessed October 14, 1999,

¹Deceased.

at URL <http://www.salamiran.org/Media/IranNews/9908021.html>).

In 1998, NIOC underwent an organizational restructuring. A new subsidiary, Khazar Exploration and Production Co., was formed to operate in the disputed Caspian region.

Commodity Review

Metals

Aluminum.—Primary aluminum production was, for the most part, derived from the 120,000-metric-ton-per-year (t/yr)-capacity Iranian Aluminium Company plant in Arak. During 1998, aluminum ingot production was about 10% higher than production during the Iranian year 1376. Construction continued at the 110,000-t/yr-capacity Al-Mahdi aluminum smelter at Bandar Abbas, which was operating at less than 10% of its capacity (Middle East Economic Digest, 1998b). Also under construction was a 280,000-t/yr-capacity alumina refinery at Jajarm, about 480 kilometers (km) northeast of Tehran. Bauxite was to be sourced from a mine near Jajarm and supplemented by imported bauxite from Guinea.

Copper.—China National Non-Ferrous Metals Co. was building a \$106 million copper smelter in Khatounabad, 20 km from the Sar Cheshmeh copper complex in Rafsanjan in southeastern Iran, for National Iranian Copper Industries Co. (NICICO). The 80,000-t/yr-capacity Khatounabad smelter was expected to import copper concentrates from Chile supplemented by production from the new open pit Meyduk Mine (Mining Journal, 1998). The mine at Meiduk, 120 km northwest of Sar Cheshmeh, was under development with the assistance of a subsidiary of Finland's Outokumpu Oyj. NICICO reported reserves at Meyduk of 140 million metric tons (Mt) grading 0.8% copper (National Iranian Copper Industries Co., [undated], Meyduk copper complex, accessed October 15, 1999, at URL <http://www.nicico.com/meyduk.html>). NICICO also was studying the proposed mining of the Songun copper deposit, a 660-Mt resource grading 0.7% copper, about 600 km northwest of Tehran (National Iranian Copper Industries Co., undated, Songun copper complex, accessed October 15, 1999, at URL <http://www.nicico.com/songun.html>).

In 1997, NICICO inaugurated a heap-leach operation at Sar Cheshmeh to process about 27 Mt of copper oxide ores averaging 0.61% copper that had been stockpiled since the mine opened. The leachate was processed in a solvent extraction-electrowinning plant capable of producing 14,000 t/yr of copper cathode (National Iranian Copper Industries Co., undated, Leaching, accessed October 15, 1999, at URL <http://www.nicico.com/leaching.html>). NICICO also proposed to increase sulfide ore processing at Sar Cheshmesh by expanding the concentrator plant's capacity from 13.4 million metric tons per year (Mt/yr) to 26.8 Mt/yr and doubling the smelter's capacity to 200,000 t/yr (Mining Journal, 1998).

The Ehya Sanaye Khorasan Co. of Iran was evaluating the rehabilitation of the Taknar copper mine, which has been closed since 1979.

Gold.—Union Itok International AG of Switzerland, a joint venture of Iran Itok Engineering and Technology Co. of Iran

and Union Mining NL of Australia, applied for copper and gold exploration licenses in Kerman and East Azarbayjan Provinces and for gold exploration licenses in the Dib Rostam area. Zarcen Minerals Inc. of Canada was exploring for gold on the Agh Darreh prospect in northwestern Iran and the Baluchestan project in southeastern Iran.

Iron and Steel.—Affiliated companies of the state steel company National Iranian Steel Co. (NISCO) began looking for new markets as domestic demand for steel dropped off in 1998. Sales to eastern Asia also were depressed as the Asian financial crisis continued. Eurofer, the European steel-trading group, alleged that Iran significantly increased its steel exports to Europe. Mobarakeh Steel Co., however, claimed that its exports to Europe had, in fact, dropped (Metal Bulletin, 1998). In 1998, Mobarakeh inaugurated the seventh stand in its hot strip mill and continued the expansion of its 2.9-Mt/yr steel plant to 4 Mt/yr.

Lead and Zinc.—Most of the nation's lead and zinc production was derived from three mines—Angouran, Irankouh, and Kushk. Most lead and zinc companies exported concentrate; however, there was metal produced at the 40,000-t/yr-capacity lead smelter at Angouran. This output was supplemented by secondary lead recovery estimated to be about 10,000 t/yr. A 7,000-t/yr-capacity zinc smelter, also at Angouran, started up in 1997, and a 27,000-t/yr-capacity zinc smelter was under construction at the Kushk Mine, near Yazd (Mining Journal, 1999).

Titanium.—Union Itok was negotiating for an exploration license for the Kahnook titanium prospect in southern Iran.

Industrial Minerals

Iran produced a wide variety of industrial minerals and mineral-based commodities, including barite, cement, clays, chemical fertilizers, gypsum, lime, phosphate, salt, dimension stone, and sulfur. Limestone deposits suitable for cement production were located close to major cities. In 1998, Iran's cement manufacturers continued to expand the country's production capacity. Hornuzgan Cement Co. was building a second 1-Mt/yr-capacity line at its plant, and the Ehdas San'at Co. had eight cement plants under construction.

More than 1.8 Mt of chemical fertilizer was produced at the Khorassan Petrochemical Complex in the year ending March 20, 1998. Ammonia was produced at the 330,000-t/yr-capacity Khorassan Petrochemical Complex, the 660,000-t/yr-capacity Razi Chemical Complex, and the 432,000-t/yr-capacity Shiraz nitrogenous fertilizer plant (Middle East Economic Digest, 1998a; Arab Petroleum Research Center, 1999, p. 147-149; Iran News, August 5, 1998, Iran plant raises urea output to 47,700 tons per month, accessed October 15, 1999, at URL <http://www.salamiran.org/Media/IranNews/980805.html>).

Iran was a significant producer of ceramic tile, with a reported production capacity of more than 50 million square meters. Dimension stone quarries produced granite, marble, and travertine. The Government sought to expand exportation of tile and stone to the international market (Iran News, July 16, 1998, Tile industry faces grave danger, accessed October 15,

1999, at URL <http://www.salamiran.org/Media/IranNews/980716.html>; Iran News, August 11, 1998, Iran quarries 7.5 m tons of stone annually, accessed October 15, 1999, at URL <http://www.salamiran.org/Media/IranNews/980811.html>).

Mineral Fuels

Natural Gas.—Highlights of the 1998 exploration season included the discovery of 952 billion cubic meters of gas, 135 km south of Shiraz (Middle East Economic Digest, 1998g).

Pars Oil and Gas Co., a NIOC subsidiary, was appointed operator of Phase 1 of the offshore South Pars natural gas development project, succeeding state-owned Petroleum Development and Engineering Co. Under construction were onshore gas treatment plants, gas pipelines, and port facilities for condensate and sulfur exports expected to be generated by Phases 2 and 3 of the South Pars gas project. The Total S.A. of France (40%), the open joint-stock company Gazprom of Russia (30%), and Petronas Carigali Sdn. Bhd. of Malaysia (30%) consortium projected that gas production from Phases 2 and 3 would start in 2001 and eventually reach a rate of 57 million cubic meters per day of natural gas (Oil & Gas Journal, 1998).

Petroleum.—In 1998, Iranian oil production reportedly had dropped to an average of 3.63 Mbbl/d, partially in response to the Organization of the Petroleum Exporting Countries' announced production quota reductions of March and June. In 1997, Iran had produced an average of 3.66 Mbbl/d (U.S. Department of Energy, [undated], Table 1.1a—World crude oil production (including lease condensate), 1990-present, International Petroleum Monthly, accessed October 27, 1999, at URL <http://www.eia.doe.gov/emew/ipsr/t11a.txt>). In 1998, new production came on-line with the startup of the Sirri A Field by a Total and Petronas joint venture. Initial oil production from the Sirri E Field was expected on-line in early 1999.

Rehabilitation work continued in the Karanj and the Parsi fields where gas injection facilities were under construction. Many of Iran's mature fields suffered from pressure-maintenance problems and increasing water production (Arab Petroleum Research Center, 1999).

In December 1998, a joint venture was formed by Lasm Petroleum Development BV, the Royal Dutch/Shell Group, and NIOC to explore the southern Caspian Sea. In the Gulf, the Agip Division of Eni S.p.A. of Italy and the Elf Aquitaine Group of France were authorized to redevelop the offshore Doroud 1 and 2 Fields. NIOC calculated that the Doroud project would increase production by 145,000 barrels per day (bbl/d) (Middle East Economic Digest, 1998c). Development of the Balal prospect, about 110 km southwest of Lavan Island, was assigned to the joint venture of Premier Oil plc of the United Kingdom (75%) and Bow Valley Energy Ltd. of Canada (25%). In September 1998, Premier had replaced Bakrie Minorak Petroleum of Indonesia, which had withdrawn from the Bow Valley venture in January.

The country's nine existing oil refineries were operated by the National Oil Refining and Distribution Co. (NORDCO). Capacity of the Bandar Abbas refinery was to approach 232,000bbl/d after it overcame startup problems, pushing the NORDCO's throughput capacity past 1.5 Mbbl/d.

Infrastructure

Major investments are required for further development of the nation's infrastructure. There are 158,000 km of highway, about 7,300 km of railroad, and 904 km of navigable waterways in the country. Pipelines for crude oil total 5,900 km; petroleum products, 3,900 km; and natural gas, 4,550 km. Crude oil is exported from the Cryus, the Kharg Island, the Lavan Island, the Ras Bahregan, and the Sirri Island terminals. Refined products were exported through the Abadan and the Bandar Mahshar terminals on the Shatt al-Arab waterway.

In March, international oil companies operating in Central Asia signed an oil swap agreement with Iran. This alternative export option for crude oil from Central Asia was initiated in July when Dragon Oil plc of Ireland began delivery of 7,200 bbl/d to Neka, Iran, in return for NIOC delivering an equivalent amount of Iranian light crude available at an Arabian Gulf port. Monument Oil and Gas plc of the United Kingdom also signed an oil swap agreement with NIOC, as a way to market proposed oil production from Turkmenistan. Iran proposed to build a 392-km, 350,000-bbl/d oil pipeline connecting Neka to the crude oil pipeline in Tehran to facilitate oil swaps with Central Asian countries (Petroleum Economist, 1998).

Total installed electricity generating capacity exceeded 23,000 megawatts (MW). Most of this capacity is attributed to natural-gas-fired thermal powerplants (Knott, 1999). New electricity-generating plants coming on-line in 1998 included two 125-MW gas turbine generators at the Khoy powerplant and a 200-MW unit at the Martyr Montazeri powerplant in Isfahan. The two new 100-MW steam units at the Qom powerplant increased the generating capacity at Qom to 714 MW. Combined-cycle powerplants with a total electricity generating capacity of 6,000 MW were under construction in 1998 as were eight hydroelectric powerplants with a total projected electricity generating capacity of 8,000 MW (Iran News, August 6, 1998, Bitaraf—Eight hydroelectric power stations under construction, accessed October 15, 1999, at URL <http://www.salamiran.org/Media/IranNews/980806.html>).

Outlook

Iran could diversify its industrial base to reduce its reliance on the oil sector. By increasing nonoil exports and producing domestically many goods that it now imports, Iran could dampen the cyclic nature of its oil-based economy. Expansion of the mineral industry can be expected as trends favoring privatization and foreign investment continue.

The metals sector offers the most promising avenue for diversification. Here, Iran has a number of comparative advantages, such as low labor costs and, when developed, abundant energy from natural gas. In terms of steel production, there are sizable if relatively low-grade iron ore deposits, and domestic supplies of coking coal and limestone could support the development of a significant steel industry.

Iran's geographic position also offers opportunities as a potential export route for crude oil from Central Asia.

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Major Sources of Information

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TABLE 1
IRAN: PRODUCTION OF MINERAL COMMODITIES 1/ 2/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997 e/	1998 e/
METALS					
Aluminum:					
Bauxite, gross weight	68,000	148,000	150,000	150,000	260,000
Metal, primary ingot	116,200	119,400	80,100	92,300	88,000
Arsenic, orpiment and realgar, concentrates e/	500	500	500	492	500
Chromium, chromite, mine output, concentrate (48% to 50% Cr ₂ O ₃):					
Gross weight	354,100	371,100	130,220	168,984 3/	170,000
Cr ₂ O ₃ content e/	173,500	181,840	63,800	82,800	83,000
Copper:					
Mine output:					
Ore mined (1% to 1.2% Cu):					
Gross weight thousand tons	12,400	13,150	14,150	14,200	14,500
Cu content e/	100,040 3/	120,000	120,000	117,300	115,000
Concentrate (29% to 35% Cu):					
Gross weight e/	360,000	325,000	320,000	320,000	320,000
Cu content	117,900	102,200	107,600 e/	108,000	108,000
Metal:					
Smelter output, blister/anode	131,800	106,100	99,100	99,000	100,000
Refined output, cathode	90,200	90,400	99,200	103,300	105,000
Gold, mine output, Au content 4/ kilograms	723	630	640	684 3/	822
Iron and steel:					
Ore and concentrate:					
Gross weight thousand tons	8,690	9,080 e/	9,850	12,750	12,300
Fe content e/ do.	4,300	4,500	4,800	6,300	6,000
Metal:					
Pig iron do.	1,883	1,532	1,867	2,053 3/	2,050
Direct-reduced iron do.	2,861	3,301	3,778	4,380 3/	4,400
Ferrochromium	7,150	11,900	10,500	11,450 3/	13,745 3/
Ferrosilicon e/	--	10	20	20	20
Steel, crude, ingots and castings thousand tons	4,498	4,696	5,415	6,322 3/	5,600
Lead:					
Mine output, concentrate (56% to 60% Pb):					
Gross weight e/	30,000	30,000	30,000	37,000	38,000
Pb content	18,300	15,900	15,700 e/	18,200	19,000
Refinery output, includes secondary	51,300	45,200	46,900	49,400	47,000
Manganese, mine output, (30% to 35% Mn):					
Gross weight	96,115	99,332	100,000	135,000	190,000
Mn content e/	30,757	32,000	32,000	40,000	60,000
Molybdenum, mine output, concentrate (56% Mo): e/					
Gross weight	1,200	1,600	1,600	1,800	1,800
Mo content	670	560	560	600	600
Silver, mine output, Ag content e/	60	60	60	60	60
Zinc:					
Mine output, concentrate (50 to 55% Zn):					
Gross weight e/	146,000	290,000	152,000	132,000	160,000
Zn content	73,000	145,100	76,300	76,500	80,000
Metal	--	--	--	14,000	23,000
INDUSTRIAL MINERALS					
Asbestos: e/					
Concentrate, (3% to 8% marketable fiber)	80,000	65,000	65,000	86,200	86,000
Marketable fiber	4,500	4,500	4,500	4,300	4,300
Barite e/	139,000	150,000 3/	150,000	181,174 3/	180,000
Boron, borax e/	500	500	500	420	420
Cement, hydraulic e/ thousand tons	16,000	16,300	18,350 r/	19,250 r/	19,000
Clays:					
Bauxite and refractory clays e/	220,000	220,000	220,000	215,000	215,000
Bentonite	71,759	54,789	85,000	105,300 3/	115,000
Other: e/					
Industrial clays	300,000	250,000	300,000	350,000	450,000
Kaolin	265,591 3/	250,000	350,000	510,000	600,000
Total	565,591 3/	500,000	650,000	860,000	1,050,000
Diatomite e/	90	90	90	90	90
Feldspar	75,000	80,000 e/	106,000	125,000 3/	125,000

See footnotes at end of table.

TABLE 1--Continued
IRAN: PRODUCTION OF MINERAL COMMODITIES 1/ 2/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997 e/	1998 e/
INDUSTRIAL MINERALS--Continued					
Fluorspar, fluorite	22,204	20,163	20,000 e/	20,000	20,000
Gemstones, turquoise e/ kilograms	5,000	5,000	5,000	5,000	5,000
Gypsum thousand tons	8,430	8,230	8,570	8,900	9,750
Industrial or glass sand (quartzite and silica) e/	950,000	1,000,000	1,000,000	1,000,000	1,000,000
Lime e/ thousand tons	650	650	650	650	700
Magnesium compounds e/	45,000	55,000	55,000	55,000	55,000
Mica e/	3,000	3,000	3,000	3,000	3,000
Nitrogen:					
N content of ammonia	696,200	715,400	882,000	879,800 3/	1,034,000
N content of urea	400,000	421,800	552,900	610,500 3/	800,000
Perlite e/	6,000	6,000	6,000	6,000	6,000
Pigments, mineral, natural iron oxide e/	2,500	2,500	2,500	2,500	2,500
Pumice and related volcanic materials e/	200,000	200,000	200,000	200,000	150,000
Salt	1,050,000	936,000	1,000,000 r/ e/	1,180,000 r/	1,450,000
Sodium compound, caustic soda e/	15,000	15,000	15,000	15,000	20,000
Stone: e/					
Construction and building, crushed, n.e.s. thousand tons	4,800	4,800	4,800	4,800	4,300
Dimension and decorative:					
Granite do.	20	20	20	20	40
Marble:					
Blocks do.	4,500	4,500	4,500	4,500	6,000
Crushed do.	450	450	450	450	500
Slabs do.	50	50	50	50	100
Travertine:					
Blocks do.	500	500	500	500	800
Crushed and slabs do.	70	70	70	70	100
Total do.	5,590	5,590	5,590	5,590	7,500
Dolomite do.	200	243 3/	200	200	200
Limestone do.	28,000	28,000	32,000 r/	33,000 r/	33,000
Strontium, celestite e/	20,000	20,000	20,000	20,000	20,000
Sulfates, natural: e/					
Aluminum potassium sulfate (alum)	12,000	12,000	12,000	12,000	12,000
Sodium sulfate	280,000	280,000	315,000 3/	480,000	480,000
Sulfur: e/					
Byproduct of petroleum and natural gas	830,000	840,000	840,000	850,000	850,000
Byproduct of metallurgical processing, S content of acid	50,000	50,000	50,000	50,000	50,000
Total	880,000 3/	890,000	890,000	900,000	900,000
Talc e/	18,000	20,000	20,000	20,000	20,000
MINERAL FUELS AND RELATED MATERIALS					
Coal thousand tons	1,720	1,640	1,840	1,750	1,810
Coke e/ do.	700	700	700	800 r/	700
Gas, natural:					
Gross million cubic meters	61,000	79,600	86,000	89,000	94,000
Dry do.	28,200	36,600	39,077	43,000	45,000
Natural gas plant liquids e/ thousand 42-gallon barrels	23,500 3/	23,500	23,500	22,000	22,000
Petroleum:					
Crude do.	1,325,000	1,329,700	1,345,390	1,337,360 3/	1,325,000
Refinery products: e/					
Liquefied petroleum gases do.	23,000 3/	24,000	23,000 r/	24,000	24,000
Motor gasoline do.	51,500	54,425 3/	54,400 r/	54,500	55,000
Jet fuel do.	9,200 3/	9,000	10,200 r/	10,000 r/	10,000
Kerosene do.	34,400	36,000	35,800 r/	36,000	37,000
Distillate fuel oil do.	107,600 3/	104,828 3/	108,800 r/	109,000 r/	110,000
Residual fuel oil do.	103,000	93,367 3/	98,600 r/	98,000 r/	100,000
Other do.	35,800 3/	45,000	64,200 r/	64,000 r/	64,000
Total do.	364,500	366,620	395,000 r/	395,500 r/	400,000

e/ Estimated. r/ Revised.

1/ Table includes data available through October 28, 1999.

2/ Data are for Iranian years ending March 21 of that stated, except data for natural gas, plant liquids, and petroleum, which are for Gregorian calendar years.

3/ Reported figure.

4/ Includes gold recovered from the Mouteh gold mine and from the Sarcheshmeh copper complex.

IRAQ

By Philip M. Mobbs and Bernadette Michalski¹

Nonfuel mineral production—principally cement, phosphate rock, salt, steel, and sulfur—was limited to satisfying domestic consumption as a result of the United Nations (U.N.) trade embargo (U.N. Security Council Resolution 661) imposed on Iraq after the 1990 invasion of Kuwait. Iraqi crude oil exports resumed in December 1996, authorized under U.N. Resolution 986 (known as the Oil for Humanitarian Aid Agreement or the oil-for-food program). This recreated an economic scenario similar to that prior to the Gulf War when crude oil and petroleum products accounted for 90% to 95% of Iraq's foreign currency earnings. By using the purchasing power parity calculation, the gross domestic product for the Iraqi centrally planned economy was estimated to be \$42.8 billion in 1997, the last year for which data are available. Proposals for renewed international investment in other mineral-related production, such as fertilizer and sulfur, have not been approved by the U.N. Security Council (Arab Petroleum Research Center, 1999, p. 154).

In December 1997, U.N. Resolution 1143 renewed the oil-for-food program for a third phase, permitting the sale of Iraqi crude oil valued at \$2 billion during a period of 180 days, ending on June 2, 1998. In February 1998, U.N. Resolution 1153 authorized an increase in value of Iraqi crude oil exports to \$5.3 billion that became effective when U.N. Resolution 1175 extended the oil-for-food program for a fourth stage from June 4, 1998, to November 25, 1998. U.N. Resolution 1175 also authorized that an amount up to \$300 million be made available to finance Iraqi requested (and U.N. approved) contracts for necessary spare parts and equipment to enable Iraq to increase its petroleum production capacity. U.N. Resolution 1210 authorized a fifth 180-day phase of the export scheme, beginning on November 26, 1998.

According to the Arab Petroleum Research Center (1999, p. 154), 66% of the oil export revenue financed the humanitarian aid for Iraq. This aid included the Iraqi import of foodstuffs, health supplies, medicine, and sundry civilian expenses for the estimated population of 21.7 million people. The U.N. Compensation Fund received 30% of export income, 3.2% of Iraqi oil proceeds was used to cover administrative costs of the program, and 0.8% was used to fund the U.N. Special Commission on Weapons Monitoring. In 1998, an average of 336,000 barrels per day (bbl/d) of crude oil was exported to the United States, about 3.9% of total U.S. crude oil imports, compared with an average of 89,000 bbl/d in 1997 and 1,000 bbl/d in 1996 (U.S. Energy Information Administration, 1999, p. 8-15).

In 1998, the state-owned South Oil Co. brought the West Qurna Oilfield on-stream. Between 1987 and 1990,

Technoexport of the U.S.S.R. drilled about 200 wells at West Qurna. Development was disrupted after the invasion of Kuwait and ensuing sanctions prohibited continued operations. Iraq produced crude oil from 15 fields of the 74 evaluated petroleum prospects in the country. Dozens of international petroleum companies were in negotiations with Iraq, actively seeking petroleum production-sharing contracts for implementation after sanctions are lifted; however, some Governments, most notably the United Kingdom and the United States, actively discouraged such negotiations (Arab Petroleum Research Center, 1999, p. 165).

Iraqi oil exports have increased with each phase of the oil-for-food program—from a volume of 670,000 bbl/d in phase 1 to 990,000 bbl/d in phase 2, 1.03 million barrels per day (Mbbbl/d) in phase 3, 1.71 Mbbbl/d in phase 4, and a projected 1.84 Mbbbl/d for phase 5. Deteriorating Iraqi pipeline and well conditions and low international oil prices, however, have restricted Iraq's ability to reach the authorized \$5.3-billion-per-180-day revenue target (Arab Petroleum Research Center, 1999, p. 172; U.S. Energy Information Agency, November 1998, Iraq, accessed September 14, 1999, at URL <http://www.eia.doe.gov/emeu/iraq.html>). Iraq was not included in the Organization of Petroleum Exporting Countries production-quota reductions of 1998, so lower world oil prices led to Iraq's increasing production to maintain its revenue stream at the expense of other oil-producing companies and nations (Corzine and Gooding, 1998; Oil & Gas Journal, 1998).

During 1998, about 760,000 bbl/d of Iraqi crude oil was piped from Kirkuk to the Ceyhan oil terminal at Yumurtalik, Turkey, on the Mediterranean Sea, and about 770,000 bbl/d was delivered to the port of Mina al-Bakr, Iraq, on the Arabian Gulf. Iraq also shipped about 90,000 bbl/d of crude oil and products to Jordan by truck under U.N. approval. In addition to official oil exports, about 5,000 bbl/d of crude oil and petroleum products were reportedly smuggled out through Iran, and about 3,000 bbl/d of diesel fuel entered Turkey at Habur (Petroleum Economist, 1998; Arab Petroleum Research Center, 1999, p. 170). About 560,000 bbl/d was produced to meet domestic fuel requirements (Middle East Economic Digest, 1998b, p. 15).

The Iraqi Ministry of Oil placed total proven crude oil reserves at 112 billion barrels and natural gas reserves at 3.1 trillion cubic meters (Arab Petroleum Research Center, 1999, p. 160 and 173).

The transportation infrastructure of this 437,072-square-kilometer Middle Eastern country included 47,400 kilometers (km) of highway, 2,032 km of standard-gauge railroad, 4,350 km of crude oil pipeline, and 1,360 km of natural gas pipeline (U.S. Central Intelligence Agency, 1999, World Factbook—

¹Deceased.

Iraq, accessed September 19, 1999, at URL <http://www.odci.gov/cia/publications/factbook/iz.html>). In November, while waiting on U.N. approval of contracts for railway rehabilitation, the Government announced that it would begin the overhaul itself (Middle East Economic Digest, 1998a).

U.N. sanctions have weighed heavily on Iraq, and although limited crude oil exports were realized during the year, the need remains for extensive repairs and refurbishment of the petroleum export network and oil well workovers if exports are to increase. With the exception of petroleum exports under the oil-for-food program, the U.N. trade embargo has remained in place, causing a severe restriction on Iraq's economy, particularly the mineral sector, which is largely dependent upon foreign capital, equipment, and replacement parts. Should there be a return to normal trade relations, Iraqi oil authorities have indicated that priority would be given to the rehabilitation of existing oil production facilities, followed by development of

already discovered giant fields, and finally the exploration of new acreage in the western desert.

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TABLE 1
IRAQ: ESTIMATED PRODUCTION OF MINERAL COMMODITIES 1/

(Thousand metric tons unless otherwise specified)

Commodity 2/ METALS	1994	1995	1996	1997	1998
Steel, crude	300	300	300	200 r/	200
INDUSTRIAL MINERALS					
Cement, hydraulic	2,000	2,108 3/	1,600 r/	1,700 r/	2,000
Nitrogen, N content of ammonia	500	500	500	500	450
Phosphate rock:					
Beneficiated 4/	1,000	1,000	1,000	1,000	1,000
Phosphorus pentoxide content	300	300	300	300	300
Salt	300	250	250	250	250
Sulfur, elemental:					
Native, Frasch	250	250	250	250	250
Byproduct 5/	225	225	225	200 r/	200
Total	475	475	475	450 r/	450
MINERAL FUELS AND RELATED MATERIALS					
Gas, natural:					
Gross million cubic meters	3,000 r/	3,500 r/	3,480 r/ 3/	4,500 r/	6,000
Dry do.	2,500 r/	3,000 r/	3,240 r/ 3/	3,600 r/	4,000
Natural gas plant liquids thousand 42-gallon barrels	10,000	10,000	10,000	10,000	8,000
Petroleum:					
Crude (including lease condensate) do.	200,000 3/	205,000 3/	213,000 3/	433,000 3/	750,000
Refinery products do.	160,000	190,000	190,000	200,000	150,000

r/ Revised.

1/ Includes data available through September 18, 1999.

2/ In addition to commodities listed, the following also were produced but information is inadequate to reliably estimate output: gypsum for cement, plaster, mortar, and other products; limestone for cement (about 1.3 metric tons per metric ton of finished cement), lime, and construction stone; clay and/or shale for cement (about 0.4 ton per ton of finished cement); other construction materials (e.g., clays for brick and tile, sand and gravel, stone); uranium and fluorine compounds from phosphate rock processing; industrial sand for foundry use and glass manufacture; and clays for ceramics and refractories.

3/ Reported figure.

4/ Estimated to contain 30% phosphorous pentoxide.

5/ Presumably from petroleum and natural gas processing.

THE MINERAL INDUSTRY OF

ISRAEL

By Bernadette Michalski¹

Israel's indigenous minerals industry was, for the most part, based on the extraction of bromine, magnesium, and potassium from the waters of the Dead Sea. Israel was the world's second largest producer of bromine following the United States. Other indigenous mineral activities were phosphate rock mining, the manufacture of cement and fertilizers, and the production of minor quantities of crude oil and natural gas. (See table 1.) A significant mineral-related industry was the cutting of diamonds and the fabrication of jewelry from imported materials. Israel opened an exchange for rough diamond in Tel Aviv offering the first tenders in late June 1998 and similar tenders about every 5 weeks thereafter; tenders allow diamond to be sold to nonbourse members who are not subject to the stringent rules of official diamond dealers.

In 1997, the latest year for which complete trade data are available, the total value of net imports by Israel was \$28.06 billion. Worked and rough diamonds accounted for about 18% of imports, or nearly \$5.1 billion, of which \$2.9 billion was imported from Belgium/Luxembourg. Imports of fuel and lubricants accounted for \$2.3 billion; this included 9 million metric tons (Mt) of steam coal delivered to the country's two coastal powerplants at Ashkelon and Hadera. About one-half of the steam coal imports are derived from Colombia, South Africa, and the United States, each delivering about 1.5 Mt. By 2001, coal consumption is expected to reach 11 million metric tons per year (Mt/yr).

In 1997, Israeli exports were valued at \$20.8 billion. Diamond exports were valued at \$5.7 billion; chemical and chemical products, at \$2.7 billion; mining and quarrying, at \$353 million; and refined petroleum and nuclear fuel exports, at \$117 million (Central Bureau of Statistics, 1999, p. 8-7 to 8-19). The port of Ashdod was the principal fertilizer export facility in Israel. In 1997, 1.3 Mt of phosphate and 1.4 Mt of potash fertilizers were loaded and shipped from Ashdod.

About two-thirds of the domestic requirement for steel reinforcing bars were supplied by Yehuda Steel Ltd. and United Steel Mills Ltd; the remaining one third was imported, amounting to 259,000 metric tons in 1997, nearly one-half of which was from Turkey. Israeli manufacturers of rebar pressured the Ministry of Industry and Trade to impose antidumping duties (Metal Bulletin, 1998). The Dead Sea Bromine Group entered into a \$30 million joint venture with Shandong Haihua Shareholding Co. of China to sell bromine in that country. The Dead Sea Bromine Group's production capacity was 250,000 metric tons per year (t/yr) of elemental bromine, accounting for about 30% of the world's production of bromine.

Cement demand declined appreciably as sales in 1998 totaled 5.10 Mt compared with 5.52 Mt in 1997. Cement production was controlled by just one producer, Nesher Israel Cement Enterprises Ltd., operating three plants. The Ramla Works with its one modern dry-process line and a further three wet lines had a combined capacity of 4 Mt/yr. The Nesher Works near Haifa operated with three wet production lines and could produce up to 2 Mt/yr of cement. The Har-Tuv Works near Jerusalem could produce 1 Mt/yr. Clinker production of about 3.6 Mt/yr was made up from the Nesher and Ramla wet-process units (1.5 Mt/yr), the Ramla dry-production line (1.5 Mt/yr), and the semidry kiln at Har-Tuv (0.6 Mt/yr).

Dead Sea Magnesium, a joint venture between the Magnesium Division of the Dead Sea Works (65%) and Volkswagen AG of Germany (35%), inaugurated production of magnesium metal in 1997 at the Demona Plant near S'dom. The project developed cost overruns and technical problems. The company reported that the project would not be profitable before 1999. Israel's Industry and Trade Ministry approved an additional \$65 million in funding to expand the capacity from 27,000 to 35,000 t/yr (Magnesium Monthly Review, 1998). Because the plant was over budget, construction was suspended in 1998 while the company sought additional investment partners for the plant. The company was considering the sale of 25% equity in its 27,000-t/yr-capacity plant to Unitech of Austria (Industrial Minerals, 1998).

Dead Sea Works sold approximately 850 t/yr of mineral-enriched brine to a magnesia plant at Mishor Rotem operated by its associate Dead Sea Periclase Ltd. During 1997, the third Aman reactor came on-stream, increasing capacity to about 95,000 t/yr of high-purity sintered magnesia serving the refractory industry and specialty magnesia markets. A 13,000-t/yr fused magnesia plant, also at Mishor Rotem, was operated by Tateho Dead Sea Fused Magnesia Co., a partnership between Dead Sea Periclase and Tateho Chemical Industries, Co. Ltd. of Japan.

Dead Sea Works announced plans to significantly expand production of potash at its S'dom operation from 2.3 to 2.8 Mt/yr (Industrial Minerals, 1997). Dead Sea Works also produced and exported about 110,000 t/yr of table, industrial, and road salt to markets in Nigeria and Norway.

Traditionally, all electric power in Israel has been generated from heavy fuel oil; however, in recent years, all new major generating capacity has been based on coal. Up to 75% of Israel's electricity supply was generated by coal-fired powerplants; the remainder, by fuel oil. Five generating plants were in existence—the Haifa, Tel Aviv, and Ashdod are oil

¹Deceased.

fired, and the Hadera and Ashkelon are coal fired. Installed generating capacity in 1997 was 7,804 megawatts, and production was 35.1 billion kilowatthours (Central Bureau of Statistics, 1999, p. 15-5). With additional units set to come on-stream in the next few years, coal will remain a consistent part of Israel's energy supply base. However, with no indigenous energy resources of its own, Israel Electric Corporation will need to explore opportunities for the development of natural gas supplies to the country. Possible supply sources are Egypt, Qatar, or Russia. Coal could be reduced to 50% of the total energy source (International Bulk Journal, 1998).

Oil and natural gas reserves were reported to be 4 million barrels and 311 million cubic meters (Tippee, 1998).

Israel's demand for bulk cargoes, such as coal for electricity generation and cement and slag for the construction industry, has prompted a wide range of development projects to enable the ports to meet the country's future needs. Some of the funding for these projects have been reduced as foreign direct

investment in Israel during 1998 totaled \$2 billion compared with \$3.5 billion in 1997 as part of the worldwide trend of reduced foreign investment owing to the world economic crises in 1998.

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TABLE 1
ISRAEL: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity 2/ METALS	1994	1995	1996	1997	1998 e/
Iron and steel, steel, crude e/	180,000 3/	200,000	203,000	203,000	203,000
INDUSTRIAL MINERALS					
Bromine: e/					
Elemental	130,000	130,000	160,000	180,000 r/ 3/	185,000 3/
Compounds	121,000	121,000	145,000	150,000	175,000
Caustic soda	32,765	44,961	45,000	45,000 e/	45,000
Cement, hydraulic	thousand tons	4,800	6,204	6,700 e/	5,400 r/
Clays: e/					
Flint clays	40,000	40,000	40,000	40,000	40,000
Kaolin	40,000	40,000	40,000	40,000	40,000
Other	8,500	8,500	8,500	8,500	8,500
Fertilizers materials, manufactured:					
Nitrogenous, N content of ammonia and urea	50,000 e/	69,700	64,600 e/	56,600	55,000
Phosphatic, P content e/	30,300	33,000	33,000	33,000	33,000
Potassic, K content e/	16,000	17,000	17,000	17,000	17,000
Gypsum e/	48,000	50,000	50,000	60,000	60,000
Lime e/	210,000	210,000	275,000 r/	275,000	275,000
Magnesia, Mg content e/	42,200	42,200	42,200	43,000	43,000
Magnesium metal	--	--	--	8,000	15,000
Phosphate rock:					
Beneficiated	thousand tons	3,961	4,063	3,839	4,047
P ₂ O ₅ content	do.	1,232	1,264	1,200	1,250
Potash, K ₂ O equivalent	do.	1,259	1,325	1,500	1,488
Salt, marketed (mainly marine) e/	do.	1,120	900 r/	800	800
Sand:					
Glass sand	176,300	222,900	225,000 e/	225,000 e/	225,000
Other e/	thousand tons	7,060	7,060	7,060	7,100
Sodium and potassium compounds, caustic soda e/	32,765 3/	32,800	32,800	32,800	32,800
Stone: e/					
Crushed	thousand tons	31,500	31,500	31,500	31,500
Dimension, marble	do.	12,000	12,000	12,000	12,000
Sulfur: e/					
Byproduct from petroleum	do.	60	60	60	60
Sulfuric acid	do.	130	130	130	130
MINERAL FUELS AND RELATED MATERIALS					
Gas, natural: e/					
Gross	thousand cubic meters	21,300	21,300	20,000	20,000
Dry	do.	21,300	21,300	20,000	20,000
Petroleum:					
Crude	thousand 42-gallon barrels	37	36	36 e/	36 e/
Refinery products:					
Gasoline	do.	19,800	20,500	20,600 e/	20,800 e/
Kerosene	do.	5,200	9,400	9,400 e/	9,500 e/
Distillate fuel oil	do.	20,500	23,400	23,500 e/	23,800 e/
Residual fuel oil	do.	28,000	24,500	24,500 e/	25,000 e/
Other	do.	13,000	13,100	13,200 e/	13,300 e/
Total	do.	86,500	90,900	91,200 e/	92,400 e/

e/ Estimated. r/ Revised.

1/ Table includes data available through June 30, 1999.

2/ In addition to the commodities listed, a variety of other crude construction materials are produced, but available information is inadequate to make reliable estimates of output levels.

3/ Reported figure.

THE MINERAL INDUSTRY OF JORDAN

By Bernadette Michalski¹

Jordan's mineral industry was focused on the production of industrial minerals, including raw materials for the construction industry. The nation ranked sixth in global phosphate rock production and seventh in potash production. Although most of the mineral production was exported, increasing quantities of phosphate and potash were being consumed in the domestic manufacture of fertilizers. Limestone was consumed by the domestic cement industry and by the Dead Sea Chemical Industries' Complex in the production of soda ash. (See table 1.) Energy needs, however, were primarily met by imports.

The Government agency responsible for all activities related to the exploration and development of minerals and mineral fuels is the Jordan Natural Resources Authority (NRA). The exploitation of Jordan's major mineral commodities and manufactures—cement, kaolin, phosphates, and potash—were all controlled by parastatals. Aggregates, basalt, calcium carbonate, dimensional stone, and glass sand were produced by private-sector firms. Foreign investors may own all or part of a business or project in most economic sectors; however, foreign ownership in the mining sector is limited to a maximum of 50%. Foreign entities are given the same rights, under the law, as Jordanian investors and may fully repatriate capital and profits. Fixed assets of a project and spare parts imported for the project are tax exempt. The corporate income tax is 15% for companies in mining and 25% for companies in trade and transport.

In 1997, the last year for which trade data are available, total exports were nearly \$1.96 billion, including nearly \$0.5 billion in phosphate, potash, and fertilizer. Minerals remained the nation's significant export earner (about 26%); this figure should rise steadily as new projects come on-stream. Imports totaled \$4.4 billion, including \$0.5 billion in fuel and other energy imports (World Bank, 1998).

Jordan was experiencing an overcapacity in the manufacture of reinforcing bar with production at 850,000 metric tons per year (t/yr) and consumption at 350,000 t/yr. Jordan's producers are rerollers. Jordan Iron and Steel Co. Ltd. (JISC) operated two small electric arc furnaces, and United Steel Co. Ltd. was trying to install its own melting shop. Imported billet, principally from the Commonwealth of Independent States, was the principal raw material. JISC, Arab Iron and Steel Industries Co. Ltd., and National Iron & Steel Industries Co. Ltd. were the first three producers in Jordan, dominating the market until the Gulf War. Jordan Steel Co. Ltd. was a 300,000-t/yr-capacity reroller that started up its Pomini-Techint plant in 1996. The company was backed by investors in Saudi Arabia and the United Kingdom. The country's other producers included Philadelphia Steel Co. Ltd., Middle East Iron and Steel

Industries Co. Ltd., and Universal Steel Co. Ltd. (Metal Bulletin, 1998).

The Government's privatization efforts sustained credibility with the sale of 33% equity in Jordan Cement Factories Co. Ltd. to Lafarge of France. The cement plants were upgraded with the objective of improving the environmental performance of the facilities particularly reduction in energy consumption (Middle East Economic Digest, 1998d).

A bromine-exporting complex will be established as a joint venture among Albermarle Holdings of the United States, Jordan Dead Sea Industries Co. Ltd., and Arab Potash Co. Ltd. (APC). The \$120 million venture of the Jordan Bromine Co. Ltd. will be built near the Al-Safi plant, which will extract bromine from the Dead Sea by using the APC's solar evaporators to produce 50,000 t/yr of bromine, 35,000 t/yr of calcium bromide, and 50,000 t/yr of tetrabromobisphenol (a flame retardant). Construction of the complex was scheduled to begin in 1999 with completion scheduled for 2002 (Industrial Minerals, 1998).

The Jordan Magnesite Co., a subsidiary of Jordan Dead Sea Industries Co. Ltd., was planning a magnesium oxide plant with a capacity of 50,000 t/yr of dead-burned magnesium oxide for the refractory industry and 10,000 t/yr of special magnesium oxide and magnesium hydroxide for the chemical and plastics industries. The plan included storage and loading facilities at Aqaba. The Jeddah Islamic Development Bank supplied a \$28 million loan for the estimated \$90 million project. Local banks were expected to provide a further \$20 million, and the balance was to come from Jordan Magnesite's capital (Middle East Economic Digest, 1998a).

Jordan Phosphate Mines Co. Ltd. will double its production of phosphoric acid and compound fertilizers to 3.3 Mt/yr and increase phosphate production from 6 to 8 Mt/yr at a cost of \$240 million (Mining Journal, 1998).

Hydro Agri Jordan Co. Ltd., a joint venture of Norsk Hydro A/S and the Jordan Phosphate Mines Co. Ltd., accepted bids for an estimated \$600 million to \$700 million turnkey facility for the production of phosphoric acid and compound fertilizers. The project includes production of 440,000 t/yr of phosphoric acid at the Shidiyeh Mine site in southern Jordan and 1.2 million metric tons per year of compound fertilizers at a site next to the existing fertilizer plant in Aqaba. Contract awards were expected in early 1999. Production was scheduled to begin in late 2001 (Middle East Economic Digest, 1998e).

APC and Kemira Agro Oy of Finland have formed a joint venture to produce 150,000 t/yr of potassium nitrate fertilizer and 75,000 t/yr of dicalcium phosphate (a cattle feed supplement). About half of the output was intended for sale in

¹Deceased.

the Middle East and eastern Mediterranean; the remainder, in the Far East. The \$70 million plant was scheduled to come on-stream in 2000. Around 120,000 t/yr of potash and 40,000 to 50,000 t/yr of phosphates will be supplied by APC for the production of these specialty fertilizers and feeds. The new plant will use Kemira's ion-exchange technology licensed by Kemira's Danish subsidiary (Middle East Economic Digest, 1998b).

Phosphate rock reserves, as reported by direct communication with the Jordan Phosphate Mines Co., Ltd., are proven at 915 million metric tons (Mt), possible at 344 Mt, and probable at 425 Mt (Jordan Phosphate Mines Co. Ltd., 1998). Crude petroleum reserves are 0.3 million barrels and natural gas is 5.6 billion cubic meters (Arab Petroleum Research Center, 1998).

The demand for electricity was expected to increase by as much as 22% between 1998 and 2000. Natural gas will supply 50% of the demand by 2000. Major consumers were the two existing power stations in Aqaba and Zerka and the planned 300- to 450-megawatt-capacity Samra plant. Imports from Egypt will be 300 million cubic meters per day, and Inter Jordan Gas Co. Ltd. will handle the distribution of natural gas throughout Jordan (Middle East Economic Digest, 1998c).

The Aqaba Railway Corp.'s 300-kilometer (km) rail line transported phosphate from the Abiad and Hassa Mines to the port of Aqaba for export. A 25-year concession contract has been offered by the Government with a caveat requiring the construction of 22- and 16-km spur lines to enable the railway to serve the new Shidiya phosphate mine and an industrial complex near Aqaba. Construction will be completed by mid-2001 and will allow for an increase in annual shipments over the rail system from about 3 to about 10 Mt by 2002 (Journal of Commerce, 1998).

Jordan's strengthening economy, commitment to infrastructure development, privatization progress, strategic regional location, and favorable investment reforms (such as reduction of taxes, and the right to repatriate profits) find favor with potential investors in spite of the uncertainties surrounding

the Middle East peace process. The joint-venture approach has brought new investors to Jordan, including the Indo-Jordan Chemicals Company, a \$170 million joint venture with India's Southern Petrochemicals Industries Co., to produce 200,000 t/yr of phosphoric acid, and the Nippon-Jordan Chemical Co., a joint venture with APC and the Japanese agricultural federation Zen-noh, Mitsubishi Corp., and Asahi Industries Co. Ltd., for a 300,000-t/yr compound fertilizer and ammonium phosphate plant in Aqaba. The development of downstream projects requires expansion of phosphate and potash production.

The World Bank plans to more than double the \$160 million loan extended to Jordan in 1998 to \$365 million in 1999. The loan should further stimulate economic growth, as well as enable the country to approach bilateral donors for matching finance for a number of projects.

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TABLE 1
JORDAN: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity 2/	1994	1995	1996	1997	1998
Cement, hydraulic thousand tons	6,400 e/	3,508 r/	3,610 r/	3,250 r/	1,386
Feldspar e/	2,500 r/	2,500 r/	2,500 r/	-- r/ 3/	4,008 3/
Gypsum	193,000	190,000 r/	190,000 r/	193,527 r/ 3/	175,807 3/
Kaolin	47,200	47,500 r/	47,500 r/	57,255 r/ 3/	78,000 3/
Lime	7,270 e/	7,275 r/	7,275 r/	4,263 r/	4,064
Natural gas, gross million cubic meters	-- r/	-- r/	-- r/	291 r/	264
Petroleum:					
Crude 42-gallon barrels	-- r/	-- r/	-- r/	14,680 r/	14,543
Refinery products: thousand 42-gallon barrels					
Liquefied petroleum do.	1,500 e/	1,500 e/	1,500	1,542 r/ 3/	1,660 3/
Gasoline do.	4,130 e/	4,500 e/	4,500 r/	4,469 r/ 3/	5,429 3/
Jet fuel do.	500 r/ e/	500 r/ e/	300 r/	253 r/ 3/	245 3/
Kerosene do.	2,000 r/ e/	2,000 r/ e/	1,500 r/	1,507 r/ 3/	1,517 3/
Distillate fuel oil do.	6,050 r/ e/	6,000 e/	6,500 r/	6,920 r/ 3/	6,882 3/
Residual fuel oil do.	6,390 r/ e/	6,500 r/ e/	7,000	7,326 r/ 3/	7,105 3/
Other do.	1,000 r/ e/	1,000 e/	1,000 r/	866 r/ 3/	783 3/
Total do.	24,070 r/	22,000 r/ e/	22,300 r/	22,883 r/ 3/	23,621 3/
Phosphate:					
Mine output:					
Gross weight thousand tons	4,218	4,983	5,355 r/	4,720 r/	5,817
P2O5 content do.	1,399	1,655	1,765 r/	1,510 r/	1,862
Phosphatic fertilizers	749,700	729,300 r/	639,800 r/	576,142 r/	579,835
Phosphoric acid	NA	NA	NA	37,761 r/	68,345
Potash:					
Crude salts thousand tons	1,550	1,790 r/	1,765	1,447 r/	1,517
K2O equivalent do.	930	1,075	1,080 r/	868 r/	910
Salt	26,000	25,000 r/ e/	25,000 r/ e/	61,000 r/	194,845
Steel, crude e/	30,000	30,000	30,000	30,000	30,000
Stone:					
Dimension, worked thousand meters	6,000	6,000	6,000	6,308 3/	6,205 3/
Limestone thousand cubic meters	5,340 r/	6,000 r/	8,000 r/	12,388 r/ 3/	8,031 3/
Marble do.	112	112	100 r/	58 r/ 3/	135 3/

e/ Estimated. r/ Revised. NA Not available.

1/ Table includes data available through July 1, 1999.

2/ In addition to the commodities listed, soda ash was produced, but output was not reported quantitatively, and available information was inadequate to make reliable estimates.

3/ Reported figure.

THE MINERAL INDUSTRY OF

KUWAIT

By Bernadette Michalski¹

The production and refining of crude oil remained the mainstay of the nation's economy, accounting for 52% of the gross domestic product and nearly 90% of Government revenues in 1998. The Government has total control of the industry. The Ministry of Oil is charged by law with the regulation of all oil and gas production, refining, transportation, and marketing in Kuwait. With the exception of the Saudi Kuwait Neutral Zone, all oil and gas operations in the country are conducted through the State-owned Kuwait Petroleum Corporation (KPC) and its subsidiaries. The Government is considering permitting foreign firms to assist in developing additional capacity, and KPC has been trying to develop a suitable model for foreign participation, particularly since any form of foreign ownership of the country's oil resources is prohibited. Foreign companies will be limited to operating service agreements, and title to all hydrocarbons produced in Kuwait will remain with KPC. Foreign operating service agreements covering enhanced recovery projects in five northern fields are expected by the close of 1999 (Arab Petroleum Research Center, 1999, p. 198).

In 1998, crude oil production averaged 2.085 million barrels per day (Mbbbl/d), including production from the Saudi Kuwait Neutral Zone (Energy Information Administration, 1999). Crude oil sales decreased to 1.08 Mbbbl/d in 1998 from 1.13 Mbbbl/d in 1997. Crude oil exports declined as the industry focused on higher return petroleum products. Kuwait refined more than 40% of the crude oil it produces. In 1998, Kuwait's three domestic refineries had a combined capacity of 895,000 barrels per day (bbl/d) (Arab Petroleum Research Center, 1999, p. 206). Product exports were more than 670,000 bbl/d (Arab Petroleum Research Center, 1999, p. 207).

The State-owned Petrochemicals Industries Company's plans for constructing a \$1 billion world-scale aromatics plant were

delayed because of the depressed chemical market (Middle East Economic Digest, 1998). Also, construction of the 2,400-megawatt power station at Al-Zour was postponed because oil prices decreased to record lows in 1998.

Construction plans continued, however, for the United Steel Industrial Company's (USIC) \$58 million rolling mill, with a capacity of 500,000 metric tons per year (t/yr) of reinforcing bars. USIC was a joint venture between local investors and the National Iranian Steel Company, which held a 40% interest. Local market demand for rebar was 400,000 t/yr. Surplus production was likely to be exported to Saudi Arabia. Billets for the mill will be supplied by Iranian plants (Middle East Economic Digest, 1999).

Petroleum reserves were estimated to be 96.5 billion barrels. Of this number, 94 billion barrels are located in Kuwaiti territory, and more than one-half, or 55 billion barrels, were located in the Burgan Field. The remaining 2.5 billion barrels represented Kuwait's share of the reserves in the Saudi Kuwait Neutral Zone (Arab Petroleum Research Center, 1999, p. 197).

For more extensive coverage of the minerals industry of Kuwait, see the 1997 Minerals Yearbook, Volume III, International Review of Africa and the Middle East.

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¹Deceased.

TABLE 1
KUWAIT: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997	1998 e/
Chlorine	35,000	50,000	50,000 e/	45,625 r/	45,000
Cement e/ thousand tons	1,000	1,950	2,000	2,000	2,000
Clay products, nonrefractory, sand lime bricks e/ cubic meters	100,000	100,000	100,000	100,000	100,000
Lime, hydrated and quicklime e/	35,000	35,000	35,000	35,000	35,000
Natural gas: 2/					
Gross million cubic meters	7,560	10,870	10,890	10,870	10,860
Dry do.	5,970	9,280	9,300	9,250	9,260
Natural gas liquids e/ thousand 42-gallon barrels	42,000 3/	45,000	45,000	45,000	45,000
Nitrogen:					
N content of ammonia	320,000	492,800	411,900	432,000	430,000
N content of urea	324,100	390,800	356,300	348,500	348,000
Petroleum:					
Crude 2/ thousand 42-gallon barrels	742,000	752,265	743,047	760,295 r/	761,025 3/
Refinery products:					
Gasoline, motor do.	21,316	16,170	13,874	15,475	15,500
Kerosene do.	45,100	49,494	44,202	49,303	49,300
Distillate fuel oil do.	90,702	88,914	86,742	96,754	96,800
Residual fuel oil do.	88,290	66,940	73,770 r/	82,270 r/	82,300
Other do.	40,150	78,402	52,067	58,882	58,900
Total do.	285,558	299,920	270,655	302,684	302,800
Salt	36,897	37,038	100,000 e/	100,000 e/	100,000
Sodium and potassium compounds, caustic soda	30,000	60,000	78,000	78,329	78,000
Sulfur:					
Elemental, petroleum byproduct	200,000	559,000	595,000	664,000	665,000
Sulfuric acid e/	5,000	10,000	10,000	10,000	10,000

e/ Estimated. r/ Revised.

1/ Table includes data available through February 15, 2000.

2/ Includes Kuwait's share of production from the Partitioned Zone.

3/ Reported figure.

THE MINERAL INDUSTRY OF LEBANON

By Bernadette Michalski¹

In 1998, domestic mineral output was limited to the production of salt and the quarrying of raw materials for the construction industry, particularly limestone for cement manufacturing. With the change of government in 1998, the \$2.5 billion reconstruction programs under the Council for Development & Reconstruction and the Investment Development Authority of Lebanon will undoubtedly be reevaluated. Actual production data have not been reported in

recent years, but estimates have been made based on the best available information. In 1998, total imports were valued at \$7.4 billion. Petroleum products and scrap for Lebanon's steel industry accounted for the bulk of imports. Exports for the same year totaled only \$0.6 billion.

For a more extensive coverage of the mineral industry of Lebanon, see the 1997 Minerals Yearbook, Volume III, International Review of Africa and the Middle East.

¹Deceased.

TABLE 1
LEBANON: ESTIMATED PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997	1998
Cement, hydraulic thousand metric tons	3,450	3,538 2/	3,500	2,703 r/ 2/	4,100 2/
Gypsum	2,000	2,000	3,000	3,000	3,000
Iron and steel, metal, semimanufactures	80,000	80,000	80,000	80,000	80,000
Lime	15,000 r/	15,000 r/	15,000 r/	15,000 r/	15,000
Salt	3,000	3,000	3,500	3,500	3,500

r/ Revised.

1/ Table includes data available through December 1, 1999.

2/ Reported figure.

THE MINERAL INDUSTRY OF

OMAN

By Bernadette Michalski¹

In 1998, the hydrocarbon mineral sector sustained Oman's developing economy, providing about 40% of the gross domestic product (GDP) and 75% to 80% of export earnings and budget revenues (Arab Petroleum Research Center, 1999, p. 314). Other commercially viable mineral ventures included the mining of chromite; the smelting and refining of copper, with gold and silver as byproducts; the manufacturing of cement; and the production of crushed and dimension stone and sand and gravel. The mineral industry in total accounted for about one-half of the GDP.

For more extensive coverage of the mineral industry of Oman, see the 1997 Minerals Yearbook, Volume III, International Review of Africa and the Middle East.

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Major Sources of Information

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¹Deceased.

TABLE 1
OMAN: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997	1998 e/
Cement, hydraulic thousand tons	1,200	1,177 r/	1,260	1,300 e/	1,300
Chromite, gross weight	6,166	5,300 e/	15,252	18,000 2/	18,000
Copper:					
Mine output, Cu content	6,500	--	--	--	--
Metal:					
Smelter	31,200 3/	34,200 3/	24,663	22,800 2/	25,000 2/
Refinery	24,194 3/	33,900 3/	24,150	23,600 2/	22,700 e/
Gas, natural:					
Gross million cubic meters	6,000 e/	6,860 e/	9,071	8,200	8,800 2/
Dry do.	3,200 e/	3,015	6,716	7,750 2/	7,800
Gold kilograms	137	591	576	577 2/	575
Gypsum	121,446	104,490	130,900	113,600 2/	115,000
Natural gas liquids e/ thousand 42-gallon barrels	2,300	3,000	3,650	3,800	4,000
Petroleum:					
Crude do.	293,800	311,300	322,300	329,960 r/	328,500 2/
Refinery products:					
Liquefied petroleum gas do.	(4/)	404	400	450 r/	500
Gasoline do.	4,600 e/	4,632	4,888	4,200 r/	4,500
Jet fuel do.	2,500 e/	2,000 e/	2,500	1,100 r/	1,200
Kerosene do.	90 2/	1,314	90	90	90
Distillate fuel oil do.	4,800 e/	5,523	4,800	4,745 r/	5,000
Residual fuel oil do.	12,500 e/	13,606	12,500	12,775 r/	13,000
Other do.	900 e/	500	500	700 r/	700
Total do.	25,390 e/	27,575	25,278	23,610 r/	24,490
Sand and gravel thousand tons	8,000 e/	9,395	9,629	9,800	9,800
Silver kilograms	1,500 e/	100 e/	97	95	95
Stone:					
Marble thousand tons	70	145 e/	117	169 2/	170
Other do.	2,000 e/	2,119 e/	2,263	1,992 2/	2,000
Sulfur e/	40,000	35,000	30,000	30,000	30,000

e/ Estimated. r/ Revised.

1/ Table includes data available through December 1, 1999.

2/ Reported figure.

3/ Includes toll/custom output.

4/ Included in "Other" category in 1994.

THE MINERAL INDUSTRY OF

QATAR

By Bernadette Michalski¹

Although the burgeoning natural gas and petrochemical industries will soon diminish the role of petroleum revenues in the Qatari economy, oil accounted for nearly 80% of total exports, 62% of Government revenues, and 38% of the gross domestic product in 1998. The 35% decline in crude oil prices, although partially offset by increased volume, had an adverse effect on the economy, causing several projects to be postponed (Middle East Economic Digest, 1998b).

The Qatar Steel Company, Ltd. (QASCO), achieved record production in 1998 while the output of cement maintained a steady pace.

The country's major trading partners were Brazil, the European Union, the Gulf Cooperation Council (GCC) nations, India, Japan, the Republic of Korea, and the United States. Qatar imported pelletized iron ore from Bahrain and raw materials for the steel and construction industries from the European Community, Japan, and the United States. Other imports from the United States included aluminum semimanufactures; heavy machinery; nonferrous metals, such as copper and copper alloys; power-generating machinery and equipment; vehicles; and zinc and zinc alloys. Almost all the output (90%) from QASCO was exported, mostly to the GCC countries.

A 240,000-metric-ton-per-year (t/yr)-capacity aluminum smelter, a joint venture between Qatar and Norsk Hydro ASA of Norway, was anticipated by 2002. A second-stage expansion would raise capacity to 470,000 t/yr in 2004 (Platt's Metals Week, 1998).

Qatar Hot Briquetted Iron Company Ltd. was on schedule in the development of a 2-million-metric-ton-per-year (Mt/yr)-capacity, \$400 million hot-molded briquetted iron plant to be inaugurated by the second half of 2000. QASCO held 31% equity; Gulf Investment Co., National Industries Co. of Kuwait, and Duferco International Investment Co. Ltd., the Swiss-Italian trading house, each held 16.33%; and Qatar Industrial Manufacturing Co. and Qatar Shipping Co. each held 10%. Duferco will purchase 60% of production, and QASCO, the manager of the project, and National Industries Co. of Kuwait will take 20% each. Ore supply contracts for the plant were signed with Companhia Vale do Rio Doce of Brazil and Luossavarra-Kiirunavaara AB of Sweden (Metal Bulletin, 1998).

The Government, through Qatar General Petroleum Corp. (QGPC), was involved in two major liquefied natural gas (LNG) ventures with foreign partners; both were at Ras Laffan, the nearest landfall to the offshore North Field. Qatar Liquefied Gas Co., the first venture, was owned by QGPC (65%), Total SA of France and Mobil Oil Corp. of the United States (10%

each), and Marubeni Corp. and Mitsui & Co. of Japan (7.5% each). The first 2-Mt/yr-capacity train was commissioned in 1996; the second, in early 1997; and the third will be commissioned in 1999 (Oil & Gas Journal, 1997; Arab Petroleum Research Center, 1999, p. 334-338).

Ras Laffan LNG Co. (RASGAS), the second LNG venture, was owned by QGPC (66.5%), Mobil (26.5%), Itochu Corp. of Japan (4%), and Nissho Iwai Corp. of Japan (3%). RASGAS was developing a 5-Mt/yr-capacity LNG plant at Ras Laffan. Construction of the first two 2.5-Mt/yr-capacity trains was completed by yearend 1998 (Middle East Economic Digest, 1998a). An agreement was concluded with Korea Gas Corp. to double the volume of LNG exports initiated in an earlier agreement to 4.8 Mt/yr from 2.4 Mt/yr during a 25-year period. The agreement called for 600,000 metric tons of LNG to be delivered in 1999, and increasing to the contractual maximum of 4.8 million metric tons in 2002. In September 1998, RASGAS was awarded a 20- to 25-year contract for 7.5 Mt/yr to Petronet LNG of India.

The oil price slump caused some delays in the installation of permanent gas production facilities at Al-Shaheen Field. The tenders for the Dukhan Field gas lift project also were put on hold. Crude oil production increased significantly to an average of 695,000 barrels per day (bbl/d) in 1998 compared with 658,000 bbl/d in 1997 and 510,000 bbl/d in 1996. Increased output from Al-Shaheen and the newly commissioned Al Khaleej Field accounted for the rapid rise in production. Al-Shaheen, operated by Mærsk Oil Qatar AS, a subsidiary of Mærsk Olie og Gas AS of Denmark, produced around 100,000 bbl/d. Mærsk planned to increase production to 150,000 bbl/d by 2000. Located in Block 5, about 70 kilometers off Qatar's northeastern coast, Al-Shaheen produced a sour 29° to 33°API crude oil with 1.7% to 2% sulfur. Upon the installation of a gas-gathering system, the field was expected to produce approximately 3.5 billion cubic meters per day of associated gas (Arab Petroleum Research Center, 1999, p. 321, 327-328, and 330).

In recent years, Qatar has initiated a number of new policies to increase oil production, to locate additional oil reserves before existing reserves become too expensive to recover, and to invest in advanced oil recovery systems to extend the life of existing fields. One such policy has been the improvement in the terms of exploration and production contracts and production-sharing agreements. During the next several years, \$27 billion will be invested to expand hydrocarbon production capacities in Qatar's upstream and downstream sectors. Of the \$27 billion, more than half, or about \$17.8 billion, will come from foreign companies (Arab Petroleum Research Center,

¹Deceased.

1999, p. 327-328 and 334-341).

Proven reserves of crude oil are considered to be between 3.7 billion and 5 billion barrels. Natural gas reserves are estimated to be 8.5 trillion cubic meters. The bulk of the reserve, or 6.8 trillion cubic meters, is nonassociated gas from the North Field (Arab Petroleum Research Center, 1999, p. 317).

Qatar had an electric generation capacity of 2,025 megawatts (MW). In March 1998, the Qatari Government took a small step towards privatizing its power sector. The Ministry of Electricity and Water, which controlled virtually all the country's powerplants, agreed to transfer operation and maintenance responsibilities of the Ras Abu Fontas-B plant to the Qatar Electricity & Water Company (QEWCo), which was controlled by local investors (57%) and the Government (43%). The plant was the country's largest and newest power and water-desalination plant. It had an electric generation capacity of 650 MW and water output of 33 million gallons per day. The operation and maintenance responsibilities were transferred to QEWCo in July 1998 (Arab Petroleum Research Center, 1999, p. 342-343).

The North Field natural gas projects continue to be given top priority, and if they attain their full development by 2010, as planned, they should underwrite Qatar's economic well being through the next century. Other mineral industry projects may be in a more-tenuous position in the near term as Government oil revenues decline owing to low world oil prices.

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TABLE I
QATAR: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity 2/	1994	1995	1996	1997	1998 e/
Cement, hydraulic	469,502	475,380	690,000	700,000 e/	700,000
Gas, natural:					
Gross million cubic meters	18,300	18,800	18,950	24,210 r/	27,000
Dry do.	13,500	13,600	13,700	1,790 r/	21,500
Iron and steel, metal:					
Direct-reduced iron thousand tons	610	622	632	570	706 3/
Steel, crude do.	572	614	626	616	646 3/
Semimanufactures:					
Billet do.	610	606	617	608	637 3/
Bars do.	600	601	601	596	597 3/
Natural gas liquids e/ thousand 42-gallon barrels	18,200	18,500	21,000	22,000 3/	22,000 3/
Nitrogen:					
N content of ammonia	646,055	653,462	635,027	942,500 r/	579,000 3/
N content of urea	394,600	407,500	715,000 r/	670,000 r/	777,000 3/
Petroleum:					
Crude thousand 42-gallon barrels	138,200	142,300	186,150	236,885 r/	254,040 3/
Refinery products:					
Gasoline do.	4,661	4,441	3,942	4,000 e/	4,000
Kerosene do.	3,377	3,217	3,321	3,350 e/	3,350
Distillate fuel oil do.	5,480	5,126	6,997	7,000 e/	7,000
Residual fuel oil do.	6,278	6,064	6,860	6,900 e/	6,900
Other do.	1,000	900	1,100	1,100 e/	1,100
Total do.	20,796	19,748	22,220	22,350 e/	22,350
Stone, limestone e/ thousand tons	900	900	900	900	900
Sulfur e/	62,000	50,000	45,000	65,000	65,000
Urea	858,000	886,000 e/	870,000	875,000 e/	875,000

e/ Estimated. r/ Revised.

1/ Table includes data available through March 16, 2000.

2/ In addition to commodities listed, clays, gypsum, and sand and gravel for construction purposes are produced, but available information is inadequate to make reliable estimates of output levels.

3/ Reported figure.

THE MINERAL INDUSTRY OF SAUDI ARABIA

By Bernadette Michalski¹ and Philip M. Mobbs

In 1998, the Kingdom of Saudi Arabia, the world's largest producer of crude oil, accounted for about 12.5% of the total world output, a slight decrease from 12.7% in 1997 and 12.9% in 1996. In recent years, the Kingdom has achieved a diversity in its mineral industry through the development of gold mining operations and value-added cement, fertilizer, petrochemical, and steel manufacturing facilities, but petroleum accounted for nearly 85% of export earnings, about 70% of Government revenues, and about 36% of the gross domestic product (GDP) (Arab Petroleum Research Center, 1999, p. 352). In 1998, the Saudi Arabian GDP was estimated to be \$128.9 billion,² down from \$146.5 billion in 1997 (World Bank, 2000, Saudi Arabia—Country tables, accessed April 14, 2000, via URL <http://www.worldbank.org/data/countrydata/countrydata.html>).

Production

In 1998, the average production of crude oil, including the Saudi Arabian share of production from the Partitioned Zone shared with Kuwait, was 8.33 million barrels per day (Mbbbl/d) (Arab Petroleum Research Center, 1999, p. 360). Petroleum production capacity was increased to 10.8 Mbbbl/d in 1998 when production from the Shaybah Field began. Output has been averaging more than 8 Mbbbl/d in recent years in accordance with the quota assigned by the Organization of the Petroleum Exporting Countries (OPEC). Saudi Arabia also produced cement, dimension stone, ferroalloys, fertilizers, gold, salt, and concentrates that contain copper, lead, silver, and zinc. Steel was produced from scrap and imported iron ore pellets.

Structure of the Mineral Industry

All minerals, including petroleum and natural gas, were owned by the Government. The Deputy Ministry for Mineral Resources (DMMR), with the cooperation of the U.S. Geological Survey (USGS) and the Bureau de Recherches Géologiques et Minières of France, has been exploring and assessing the mineral resources of the Kingdom for more than 30 years. The DMMR has catalogued approximately 1,300 precious metal occurrences and 1,200 base metal sites. Existing exploitation was predominantly controlled by state-owned organizations; the DMMR, however, had identified an initial group of about 64 potentially economic mineral projects and had begun to promote the development of these mining projects to private investors (U.S.-Saudi Arabian Business Council,

April 3, 2000, The Saudi Arabian economy, accessed April 26, 2000, at URL <http://www.us-saudi-business.org/economy.htm>; Permanent Mission of Saudi Arabia to the United Nations, [undated], Natural resources development in Saudi Arabia, accessed April 26, 2000, at URL <http://www.un.int/saudi-arabia/ch7-6pln.htm>).

The state-owned Saudi Arabian Mining Co. (Ma'aden) was engaged in mineral exploration and mining activities in Saudi Arabia. In 1998, the Government-owned Saudi Arabian Oil Co. (Saudi Aramco) was the only company authorized to engage in oil and gas exploration and development within Saudi Arabia. Arabian Oil Co. and Saudi Arabian Texaco Inc. operated in the Partitioned Zone. Many industrial projects, including petrochemical processing and petroleum refining, were joint ventures between Saudi firms and foreign partners. In September 1998, the Government requested proposals for natural gas development in an address to U.S. oil companies. The invitation was extended to other international companies in December (Middle East Economic Digest, 1999a).

Commodity Review

In 1998, the Ministry of Petroleum and Mineral Resources announced that exploration licenses were available for the Az Zabirah bauxite deposit, the Jabal Sayid copper deposit, and the Wadi Sawawin iron ore deposit (Mining Journal, 1998a, b, d). The Ministry authorized the Metal Mining Agency of Japan and the Japanese International Cooperation Agency to explore for copper at Umm al-Damar in the western part of Saudi Arabia (Mining Journal, 1998c).

Metals

Gold.—Gold was recovered from the high-grade Mahd Adh Dhahab underground mine, which is 270 kilometers (km) northeast of Jiddah, and at the Sukhaybirat open pit mine, which is about 480 km northwest of Riyadh. The Saudi Company for Precious Metals, Ltd., operated the Sukhaybirat Mine, which produced 2.75 metric tons (t) of gold in 1998 compared with 1.94 t in 1997 and 2.65 t in 1996 (Northern Miner, 1999).

In 1998, Ma'aden secured mining licenses for the Al-Amar and the Al-Hajjar gold prospects. Reserves were estimated to be 2.7 million metric tons (Mt) grading 12 grams per metric ton (g/t) gold at Al-Amar and 4.2 Mt at a grade of 2.6 g/t gold at Al-Hajjar (Mining Journal, 1998d).

Iron and Steel.—Saudi Iron and Steel Co. (Hadeed) continued its expansion program. The 850,000-metric-ton-per-year-capacity flat steel rolling mill was expected to be in commercial operation in early 1999 (Metal Bulletin, 1998). Also in 1999, production from the newly built 1.1-million-

¹Deceased.

²Where necessary, values have been converted from Saudi riyals (SRIs) to U.S. dollars at the rate of SRIs3.750=US\$1.00.

metric-ton-per-year (Mt/yr)-capacity HYL-process direct-reduced iron (DRI) plant was expected to supplement output from Hadeed's three Midrex-process DRI plants (New Steel, March 1999, 17.5 million tons of HYL-process DRI, accessed April 20, 2000, at URL <http://www.newsteel.com/features/NS9903f6.htm>).

Zinc.—The mining license for the Al-Masane polymetallic deposit in southwestern Saudi Arabia was held by Arabian Shield Co. for Mining Industries, which was a joint venture of Arabian Shield Development Co. of the United States and Al Mashreq Co. for Mining Investments of Saudi Arabia. In 1998, Arabian Shield solicited and received bids for construction of the ore treatment plant and underground mine development; construction, however, was postponed because of a drop in metal prices (Middle East Economic Digest, 1998b; Arabian Shield Development Co., November 16, 1999, press release, accessed November 16, 1999, at URL http://biz.yahoo.com/pnews/991116/tx_arabian_1.html).

Industrial Minerals

In 1998, Tabuk Cement Co. commissioned a new 1.2-Mt/yr-capacity cement plant at Tabuk. The proposed 1,500-metric-ton-per-day "off-gas" technology ammonia project for United Jubail Fertiliser Co., which was a subsidiary of Saudi Basic Industries Corp. of Saudi Arabia, was postponed along with a number of petrochemical plants owing to the Kingdom's economic crisis associated with low petroleum prices (Middle East Economic Digest, 1998b, 1999b).

Mineral Fuels

Natural Gas.—The Kingdom's Master gas system had the capacity to transport 164 million cubic meters per day (Mm³/d) of natural gas. The processing plants at Berri, Shedgum, and Uthmaniya, however, had a capacity of only 113 Mm³/d. Saudi Aramco continued construction of a \$2 billion, 40-Mm³/d gas processing plant at Hawiyah (Middle East Economic Digest, 1998e, 1999a).

Petroleum.—Production.—In 1998, Saudi Arabia maintained an average production level of 8.33 Mbbl/d, which included output from the Partitioned Zone where production was shared with Kuwait. Much of the exported petroleum consisted of higher valued crude oil blends—Arabian Light (34° API gravity), Arabian Extra Light (38° API gravity), and Arabian Super Light (50.4° API gravity)—to maximize revenues while operating within the production quota allotted by OPEC. In 1998, the OPEC quota allotted to Saudi Arabia was 8.76 Mbbl/d. Because oil prices remained low in 1998, Saudi Arabia negotiated a production restraint agreement with other petroleum-exporting nations in March 1998 that resulted in a 600,000-barrel-per-day (bbl/d) cut in Saudi production (Arab Petroleum Research Center, 1999, p. 352; Middle East Economic Digest, 1999a).

In southeast Saudi Arabia, the Shaybah Field came on-stream in 1998 at about 250,000 bbl/d. The new field's designed capacity was 500,000 bbl/d of crude oil and 25 Mm³/d of natural gas, and the field has reserves of 14 billion barrels of

41.6° API gravity crude oil (Arab Petroleum Research Center, 1999, p. 259, 361; Energy Information Administration, January 2000, Country analysis briefs—Saudi Arabia, accessed April 24, 2000, at URL <http://www.eia.doe.gov/emeu/cabs/saudi.html>). In the Partitioned Zone, Saudi Arabian Texaco and Kuwait Oil Co. announced that the Humma No. 4 well tested oil (Texaco, Inc., October 5, 1998, Saudi Arabian Texaco and Kuwait Oil Company announce discovery in Partitioned Neutral Zone, accessed April 26, 2000, at URL http://144.5.4.28/shared/pr/1998pr/pr10_5.html).

Refining.—The combined capacity of eight refineries, which included the 30,000-bbl/d Al-Khafji refinery in the Partitioned Zone, was about 1.7 Mbbl/d (Energy Information Administration, January 2000, Country analysis briefs—Saudi Arabia, accessed April 24, 2000, at URL <http://www.eia.doe.gov/emeu/cabs/saudi.html>). In 1998, the \$1.5 billion upgrading and expansion that was completed at Saudi Aramco's Ras Tanura refinery increased capacity to 300,000 bbl/d. A fire at the refinery in October 1998 resulted in a temporary reduction of output (Arab Petroleum Research Center, 1999, p. 352, 364). The proposed \$1.8 billion upgrading of the Rabigh refinery was canceled in October 1998 owing to reduced availability of funding from Saudi Aramco because of the drop in international oil prices (Arab Petroleum Research Center, 1999, p. 352).

Reserves

Saudi Arabia has the world's largest known concentration of petroleum, which represented more than 26% of total proven world reserves. Proven oil reserves are 261.5 billion barrels, which included 2.5 billion barrels contained in the Saudi Arabian share of reserves in the Partitioned Zone. Saudi Arabia had a reserve-to-production ratio sufficient to last about 86 years at current (1998) production levels. The bulk of the Kingdom's reserves were contained in a few massive fields in the northeast. These included, in order of decreasing reserves, Ghawar, the world's largest onshore field; Safaniya, the world's largest offshore field; Abqaiq; Shaybah; Berri; Manifa; Zuluf; Abu Saafa; and Khursaniya (Arab Petroleum Research Center, 1999, p. 359).

Natural gas reserves were reported by Saudi Aramco to be 5.88 trillion cubic meters, which included 99 billion cubic meters in the Partitioned Zone. Most of the Kingdom's reserves were in the form of associated gas contained in the country's oilfields. Ghawar Field accounted for approximately 35% of the total gas reserves.

Infrastructure

Electric power generation and distribution are conducted by the regional authorities of the Saudi Consolidated Electric Companies, which operated powerplants with a combined installed capacity of more than 20,000 megawatts (MW). In 1998, consolidation of the regional electricity companies into the newly formed Saudi Electricity Co. was proposed. Additional power-generation capacity (2,750 MW) was under the authority of Saline Water Conversion Corp., which operated seawater-desalination plants (Arab Petroleum Research Center, 1999, p. 380-382; Middle East Economic Digest, 1998d).

Extensive port and harbor facilities served Al-Jubayl, which is on the east coast with access to the Arabian Gulf, and Yanbu, which is on the west coast with access to the Red Sea.

Outlook

Saudi Aramco intends to maintain its crude oil capacity of approximately 10.8 Mbbl/d. Less-profitable fields have been shut in as new producing fields come on-stream. Revenue increases can be anticipated through cutting back on the sale of heavier crude oil in favor of the lighter premium crudes from fields south of Riyadh.

Because most of the national income is dependent upon markets outside the Kingdom, the economy remains vulnerable to cyclical and sudden changes in volume and pattern of worldwide trade in crude and refined petroleum and petrochemicals. Direct investment in foreign refining, marketing, and distribution operations provided some stability in the face of market fluctuations.

Saudi Arabia has adopted an integrated view toward the best use of natural resources and has proposed development of the natural gas reserves to satisfy the escalating demand for electricity in the Kingdom. During the next 25 years, as much as \$140 billion in investments will be required to meet domestic power requirements (Wall Street Journal, 1997). Development of additional precious metal and industrial mineral operations will help diversify the Kingdom's mineral economy. The economy has progressed rapidly, and the standard of living has improved significantly. Dependence on petroleum revenues continued, but industry and agriculture now account for a larger share of economic activity.

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TABLE I
SAUDI ARABIA: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity 2/	1994	1995	1996	1997	1998 e/
METALS					
Ore, mine output:					
Gross weight 3/	900,000 e/	1,400,000 e/	1,569,205	1,600,000 e/	1,700,000
Copper content of concentrate and bullion 4/	917	925 e/	834 e/	703	1,000
Gold content of concentrate and bullion 3/ 4/ kilograms	7,630 e/	8,080	7,530	7,260	9,000
Lead content of concentrate e/ 4/	50	50	50	50	60
Silver content of concentrate and bullion 3/ 4/ kilograms	16,990	16,900 e/	16,608	17,200	20,000
Zinc content of concentrate e/ 4/	500	500	500	619	650
Iron and steel:					
Direct-reduced iron thousand tons	2,111	2,129	2,300	2,110	2,270
Steel, crude do.	2,411 e/	2,451	2,683	2,539	2,400
Ferroalloys	--	--	20,000 e/	83,000 e/	83,000
INDUSTRIAL MINERALS					
Barite	5,000	6,000	8,000 e/	8,000 e/	8,000
Cement, hydraulic thousand tons	16,000	15,773	16,437	15,400 4/	14,000
Gypsum, crude	375,000	370,000	362,589	365,000 e/	330,000
Lime e/	160,000	175,000	180,000	180,000	200,000
Nitrogen:					
N content of ammonia thousand tons	1,340	1,327	1,386	1,405	1,400
N content of urea do.	994	980	1,010	930	930
Pozzolan	NA	NA	144,000 e/	145,000 e/	145,000
Salt	60,000	90,000	90,000 e/	90,000 e/	90,000
Sodium hydroxide	NA	NA	450,000	450,000 e/	400,000
Sulfur, byproduct from petroleum refining e/ thousand tons	2,300	2,400	2,300	2,400	2,300
MINERAL FUELS AND RELATED MATERIALS					
Gas, natural: 5/					
Gross million cubic meters	68,000 e/	73,900	77,700	81,900 r/	83,000
Dry do.	37,700 e/	38,030	41,340	45,300 r/	46,100
Natural gas liquids: e/					
Propane thousand 42-gallon barrels	120,500	147,500	147,000	150,000	150,000
Butane do.	56,600	60,000	60,000	65,000	65,000
Natural gasoline and other do.	45,000	48,000	47,400	48,900	48,900
Total do.	222,100	255,500	254,400	263,900 6/	263,900
Petroleum:					
Crude do.	2,970,000	3,004,300	2,999,550	3,080,235	3,041,000
Refinery products:					
Liquefied petroleum gases do.	13,000 e/	11,315	12,000 e/	12,000 e/	13,000
Gasoline do.	92,800	85,000	94,462	90,200 r/	90,000
Jet fuel do.	30,000 e/	21,900	23,000	21,000 r/	21,000
Kerosene do.	36,450 e/	36,865	40,875	40,000 r/	40,000
Distillate fuel oil do.	169,800	172,280	191,990	192,000 e/	192,000
Residual fuel oil do.	156,640	167,200	180,565	165,000 r/	165,000
Unspecified do.	73,900 e/	73,400	68,000	58,000 r/	60,000
Total do.	572,590 e/	567,960	610,892	578,200 r/	581,000

e/ Estimated. r/ Revised. NA Not available.

1/ Table includes data available through April 21, 2000.

2/ In addition to commodities listed, the following were probably produced, but information is inadequate to estimate output: aggregates, clays, granite, limestone, marble, and silica sand.

3/ Production from Mahd Adh Dhahab and Sukhaybirat gold operations.

4/ Mahd Adh Dhahab produces a bulk flotation concentrate containing copper, gold, lead, silver, and zinc and a crude bullion containing copper, gold, and silver.

5/ Includes Saudi Arabian one-half share of production in the Saudi Arabia-Kuwait Partitioned Zone.

6/ Reported figure.

TABLE 2
SAUDI ARABIA: STRUCTURE OF THE MINERAL INDUSTRY IN 1998

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners		Location of facilities	Annual capacity
Cement	Saudi Consolidated Cement Co. (Government, majority shareholder)		Ayn Dar, 75 kilometers southwest of Dammam	1,875
Do.	do.		Al Hufuf	1,800
Do.	Arabian Cement Co. Ltd. (Government, 100%)		Rabigh	2,000
Do.	Southern Province Cement Co. (Government, 100%)		Suq Al Ahad, 10 kilometers northeast of Jizan	2,500
Do.	do.		Bishah, 550 kilometers southeast of Jiddah	1,300
Do.	Yanbu Cement Co. (Government, 100%)		Yanbu	1,500
Do.	Yamama Cement Co. (Government, 100%)		Riyadh	3,000
Do.	Qasim Cement Co. (Government, 100%)		Buraydah	1,400
Do.	Tabuk Cement Co. (Government, 100%)		Tabuk	1,200
Ferroalloys	Gulf Ferroalloys Co. (SABAYEK) (United Gulf Industries Corp., 26%; SABIC, 15%; Demetal Aussenhandelsgesellschaft, 7%)		Al Jubayl	105
Fertilizer:				
Urea	Al Jubayl Fertilizer Co. (SAMAD) (SABIC, 50%; Taiwan Fertilizer Corp., 50%)		do.	632
Ammonia	do.		do.	300
Urea	National Chemical Fertilizer Co. (IBN AL BAYTAR) (SABIC, 50%; SAFCO, 50%)		do.	500
Ammonia, liquified	do.		do.	500
NPK	do.		do.	500
TSP	do.		do.	200
DAP	do.		do.	100
Urea	Saudi Arabian Fertilizer Co. (SAFCO), (SABIC, 41%; Saudi Arabian private interests, 59%)		Dammam	330
Ammonia	do.		do.	200
Sulfuric acid	do.		do.	100
Ammonia	do.		Al Jubayl	500
Granular urea	do.		do.	600
Gold:				
Ore	Mahd Adh Dhahab Mining Company (Ma'aden,100%)		Mahd Adh Dhahab, 270 kilometers northeast of Jiddah	180
Metal kilograms	do.		do.	5,000
Ore	The Saudi Company for Precious Metals, Ltd. (SCPM) (Ma'aden, 50%; Boliden International Mining, 50%)		Sukhaybirat, 480 kilometers northwest of Riyadh	1,300
Metal kilograms	do.		do.	2,800
Refinery metric tons	Dahab Company Ltd. (Saudi private interests, 51%; Thomson-C.S.F., 49%)		Jiddah	110
Natural gas million cubic meters	Saudi Aramco (Government, 100%)		All oilfields, Eastern Province	60,000
Do. do.	do.		Khuff Zone, Eastern Province	20,150
Do. do.	do.		Abqaiq Gas Cap, Eastern Province	4,600
Natural gas liquids 1/ million barrels	do.		Shedgum, 150 kilometers southwest of Dammam	60
Do. do.	do.		Uthmaniya, 30 kilometers west of Al Hufuf	120
Do. do.	do.		Berri, 15 kilometers north of Al Jubayl	25
Do. do.	do.		Ju'aymah, 33 kilometers northwest of Ras Tanura	110
Do. do.	do.		Yanbu	110
Petrochemicals:				
Ethylene	Saudi Petrochemical Co. (SADAF) (SABIC, 50%; Pecten Saudi Arabia, 50%)		Al Jubayl	970
Ethylene dichloride	do.		do.	560
Styrene	do.		do.	360
Ethanol	do.		do.	300
Methyl-tertiary-butyl-ether (MTBE) and Ethyl-tertiary-butyl-ether	do.		do.	700
Sodium hydroxide	do.		do.	450

See footnotes at end of table.

TABLE 2--Continued
SAUDI ARABIA: STRUCTURE OF THE MINERAL INDUSTRY IN 1998

(Thousand metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of facilities	Annual capacity
Petrochemicals--Continued:				
Methanol		National Methanol Co. (Ibn Sina) (SABIC, 50%; Celanese Arabian, 25%; Texan Eastern Arabian, 25%)	Al Jubayl	900
Methyl-tertiary-butyl-ether (MTBE)		do.	do.	700
Methanol		Saudi Methanol Co. (Ar Razi) (SABIC, 50%; Japan Saudi Arabia Methanol Co., 50%)	do.	2,130
Ethylene glycol		Eastern Petrochemical Co. (SHARQ) (SABIC, 50%; Saudi Petroleum Development Corp., 50%)	do.	450
Linear low density polyethylene		do.	do.	660
Ethylene-1 and 2		Arabian Petrochemical Co. (Petrokemya) (SABIC, 100%)	do.	1,150
Butene-1		do.	do.	100
Polystyrene		do.	do.	135
Propylene		do.	do.	300
Butadiene		do.	do.	100
Benzene		do.	do.	70
HAO polyethylene		Al Jubayl Petrochemical Co. (Kemya) (SABIC, 50%; Exxon Chemical Arabia, Inc., 50%)	do.	170
High density polyethylene		do.	do.	170
Linear low density polyethylene		do.	do.	600
Methyl-tertiary-butyl-ether (MTBE)		Saudi European Petrochemical Co. (Ibn Zahr) (SABIC, 70%; Ecofuel, 10%; Neste Oy, 10%; Arab Petroleum Investments Corp., 10%)	do.	1,400
Polypropylene		do.	do.	800
Ethylene		Saudi Yanbu Petrochemical Co., (YANPET) (SABIC, 50%; Mobil Oil Corp, 50%)	Yanbu	500
Ethylene glycol		do.	do.	220
Polyethylene		do.	do.	96
Petroleum, crude	million barrels	Saudi Aramco (Government, 100%)	Eastern Province, Najd Region, and offshore	3,942
Do.	do.	Arabian Oil Co., (AOC), (Japan Petroleum Trading Co., 80%; Kuwait, 10%; Saudi Arabia, 10%)	Khafji 2/	110
Do.	do.	do.	Al Hout 2/	10
Do.	do.	Saudi Arabian Texaco Inc.	Wafra, South Fawaris, South Umm Gudair 2/	50
Petroleum products		Saudi Aramco (Government, 100%)	Ras Tanura	110
Do	do.	Rabigh Petroleum Refining Co. (Saudi Aramco, 100%)	Rabigh	119
Do	do.	Jubail Petroleum Refining Co. (Saudi Aramco, 50%; Shell, 50%)	Al Jubayl	110
Do.	do.	Yanbu Petroleum Refining Co. (Saudi Aramco, 50%; Mobil, 50%)	Yanbu	127
Do.	do.	Saudi Aramco (Government, 100%)	do.	69
Do	do.	Jiddah Oil Refinery Co. (Saudi Aramco, 100%)	Jiddah	38
Do.	do.	Riyadh Oil Refinery Co. (Saudi Aramco, 100%)	Riyadh	50
Do.	do.	Arabian Oil Co. (Japan Petroleum Trading Co., 80%; Kuwait, 10%; Saudi Arabia, 10%)	Al Khafji	11
Steel		Saudi Iron and Steel Co. (Hadeed) (SABIC, 95%)	Al Jubayl	2,700
Do.		Jiddah Steel Rolling Mill (Sulb) (Government, 100%)	Jiddah	245
Titanium dioxide		The National Titanium Dioxide Co. (Cristal) (Shairco for Trading and Contracting, 25%; National Industrialization Co., 24%; Gulf Investment Corp., 24%; Kerr-McGee Chemical Corp., 25%; private individuals, 2%)	Yanbu	52
Zinc		Arabian Shield Company for Mining Industries (Arabian Shield Development Co., 50%; Al Mashreq Company for Mining Investments, 50%)	Al Masdane	(3/)

1/ Natural gas is pumped through the Master Gas System to processing plants at Berri, Shedgum, and Uthmaniya where natural gas liquids are separated and sent by pipeline to fractionation plants at Ju'aymah and Yanbu.

2/ Partitioned Zone where production is shared between Saudi Arabia and Kuwait.

3/ Company holds a 30-year lease on 44 square kilometers with minable reserves of 7.2 million metric tons of ore containing copper, gold, silver, and zinc.

THE MINERAL INDUSTRY OF

SYRIA

By Bernadette Michalski¹

In 1998, natural gas and petroleum, which dominated Syria's mineral industry, accounted for 60% of the nation's exports and 40% of the gross domestic product (Financial Times, 1998). Other significant mineral industries included gypsum and phosphate rock mining, the manufacture of fertilizers and cement, and the manufacture of steel from domestic and imported scrap.

The substantial increase in natural gas production in recent years resulted from the development of five nonassociated gasfields in the Palmyra region between 1996 and 1998 and the expansion of processing facilities. In November 1998, Conoco Inc. of the United States and Elf Aquitaine Group of France signed a contract with the Syrian Petroleum Co. to develop associated gas resources in the Deir al-Zor area at a total cost of \$450 million. The project will capture natural gas being flared in conjunction with petroleum production and will include development of the Tabiyeh gas condensate field. The contract included the construction of a gas-gathering system, a gas-processing plant, and a 250-kilometer pipeline to transport more than 4 million cubic meters per day of gas to the national grid (Middle East Economic Digest, 1998a).

Crude oil production averaged 553,000 barrels per day (bbl/d) in 1998. The Al-Furat Petroleum Co., a joint venture among Syrian Petroleum Co., Syria Shell Petroleum Development B.V., and the Southern African Developing Mining and Mineral Industry Exchange (Deminex), was the country's largest producer, yielding about 340,000 to 350,000 bbl/d of 36.4° API Syrian Light crude oil. The Syrian Petroleum Co. produced nearly 150,000 bbl/d of heavy 24° API Suwaidiyah crude oil, the Deir Es-Zor Petroleum Co. produced about 40,000 to 50,000 bbl/d of light crude oil, and the Al-Khabur Petroleum Co. produced about 12,000 bbl/d from the Kishma Field, which came on-stream in late 1997.

In 1998, Tullow Oil plc of Ireland decided to abandon its Syrian operation and closed a 24% stake in the Ash-Sham East concession in the Eurhrates Basin near the Iraqi border. The field was brought on-stream at about 12,000 bbl/d, but production levels have since fallen (Middle East Economic Digest, 1998b).

Syrian refining policy was to operate its two refineries at full capacity to maximize the production of middle distillates. This policy, however, resulted in large surpluses of fuel oil and diesel oil, most of which were exported to Cyprus and Lebanon, and required the importation of about 5 million barrels per year of middle distillates for while domestic consumption.

Proven recoverable natural gas reserves were 234.5 billion cubic meters as of January 1, 1998. About 55% was nonassociated gas; 25%, cap gas; and the remaining 20%,

associated gas. Estimated recoverable petroleum reserves were 2.5 billion barrels. Syria's known hydrocarbon reserves were concentrated in seven major fields, the largest of which was Suwaydiyah in the extreme northeastern section of the country. Proven reserves of this field alone were reported to be 1 billion barrels of liquid hydrocarbons and 5.6 billion cubic meters of natural gas (Arab Petroleum Research Center, 1999, p. 417).

For more extensive coverage of the mineral industry of Syria, see the 1997 Minerals Yearbook, Volume III, International Review of Africa and the Middle East.

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Major Sources Of Information

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¹Deceased.

TABLE 1
SYRIA: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997	1998 e/
Cement, hydraulic thousand tons	5,000	4,463	5,000 e/	4,460	4,500
Gas, natural: e/					
Gross million cubic meters	5,000	5,000	5,500	6,400	8,000
Dry do.	2,800	2,900	3,000	4,560	5,900 2/
Gypsum	301,600	335,683	325,000 e/	325,000 e/	300,000
Iron and steel, steel, crude e/	70,000	70,000	70,000	70,000	70,000
Natural gas liquids e/ thousand 42-gallon barrels	1,800	1,800	2,000	2,250	2,500
Nitrogen:					
N content of ammonia	67,000	63,500	80,400	83,700	129,200
N content of urea	54,500	28,700	46,000	54,400	100,000
Petroleum:					
Crude	211,335	222,650	220,500	204,800	201,895
Refinery products:					
Liquefied petroleum gas thousand 42-gallon barrels	2,000	2,100	2,122	2,170	2,215 2/
Gasoline do.	11,100	11,907	11,406	11,400	11,785 2/
Naphtha do.	3,000	1,676	1,685	1,700	1,710 2/
Jet fuel do.	3,000	1,753	1,728	1,725	2,029 2/
Kerosene do.	1,400	1,484	1,491	1,500	1,546 2/
Distillate fuel oil do.	27,000	29,951	30,078	30,600	30,772 2/
Residual fuel oil do.	35,000	34,891	35,038	35,000	34,978 2/
Asphalt do.	1,600	1,900	1,916	1,900	1,900
Other do.	1,800	1,800	1,900	1,900	2,000
Total do.	85,900	87,462	87,364	87,895	88,935
Phosphate rock:					
Gross weight thousand tons	1,203	1,551	2,189	2,392	2,496
P ₂ O ₅ content e/ do.	371	477 2/	670	730	765
Salt	127,000 e/	111,000	72,000	70,000	163,392
Stone, sand and gravel: e/					
Stone, dimension, marble thousand cubic meters	1,800	1,800	1,156	1,150	1,200
Sand and gravel thousand tons	4,200	4,200	4,200	4,200	4,200
Sulfur, byproduct of petroleum and natural gas e/	10,000	9,824 2/	10,000	10,000	10,000

e/ Estimated.

1/ Table includes data available through December 1, 1999.

2/ Reported figure.

THE MINERAL INDUSTRY OF

TURKEY

By Philip M. Mobbs

Turkey's economy remained plagued by a combination of factors, including public sector debt, rapid devaluation of the Turkish lira, and high levels of political uncertainty, inflation, and unemployment (Barham, 1997, 1998; Middle East Economic Digest, 2000). The extremely complex geology of Turkey is reflected in the diversity of its mineral deposits. Best known for its industrial minerals, Turkey was a major producer of barite, boron minerals, celestite (strontium), emery, feldspar, limestone, magnesite, marble, perlite, and pumice. A wide variety of primary metallic minerals were produced as well, but output generally was not considered to be large compared with that of other countries. Chromite was the most significant mineral in the metal sector. Turkey was a major world producer of processed mineral commodities, including refined borates and related chemicals, cement, ceramics, and glass, and was a significant producer of ferrochromium and steel.

The primary mineral sector's contribution to the economy traditionally has been slightly more than 1% of the gross domestic product (GDP), which totaled about \$199 billion¹ in 1998 (World Bank, September 8, 1999, Turkey at a glance, accessed January 28, 2000, via URL <http://www.worldbank.org/data/countrydata/countrydata.html>). Total mineral industry (primary mineral commodities plus secondary mineral commodities, including cement, glass, refined petroleum products, steel, and certain inorganic chemicals) revenues were estimated to be about 10% of the GDP.

Government Policies and Programs

The Turkish economy was burdened by an inflation rate that dropped to about 84% in 1998 down from 86% in 1997 (World Bank, September 8, 1999, Turkey at a glance, accessed January 28, 2000, via URL <http://www.worldbank.org/data/countrydata/countrydata.html>). Mining was regulated by mining law No. 3213 of 1985. Hydrocarbon activities were regulated under law No. 6326 of 1954, law No. 6556 of 1955, law No. 6987 of 1957, law No. 1702 of 1973, and law No. 2808 of 1983.

In June, Parliament reduced corporate tax rates to 30% from 40%. The Court of Accounts ruled that the exchange-rate guarantee on the capital investment of the international oil companies was not legal. The Treasury had converted submitted funds to lira and deposited them with the Central Bank. The exchange-rate guarantee had protected the deposited funds from inflation.

Trade

As shown in table 1, Turkey produced a wide variety of mineral commodities. Mineral and chemical commodities accounted for about 21% of total Turkish exports, which were valued at \$26.9 billion in 1998 compared with \$26.2 billion in 1997. Turkey was a significant exporter of steel and ferrochromium and exported limited quantities of chromite, copper, and zinc ores and refined metals and also exported a wide variety of industrial minerals and derived chemicals, the value of which decreased to \$598 million in 1998 compared with \$613 million in 1997. The value of Turkish aluminum exports increased to \$272 million in 1998 up from \$217 million in 1997. Borates exports dropped to \$129 million in 1998 compared with \$143 million in 1997. Copper exports decreased to \$176 million in 1998 compared with \$219 million in 1997. Ferrochromium exports also decreased to \$40 million in 1998 compared with about \$68 million in 1997. Glass exports increased to \$349 million in 1998 compared with \$341 million in 1997. Iron and steel exports decreased in 1998 to \$2.2 billion compared with \$2.5 billion in 1997. Dimension stone increased to \$129 million in 1998 compared with \$119 million in 1997 (State Institute of Statistics, March 5, 1999, Provisional foreign trade figures—December 1998, accessed January 28, 2000, at URL <http://www.die.gov.tr/ENGLISH/SONIST/DISTICIST/050399.htm>; Istanbul Chemicals and Chemical Products Exporters' Association, [undated], Statistical data by product group (annually), accessed January 28, 2000, at URL <http://www.immib.org.tr/Eng/kimya/stat/urun.html>; Istanbul Ferrous and Non-ferrous Metals Exporters' Association, [undated], Ferrous & non-ferrous metal export by product group of the 1998 year, accessed January 28, 2000, at URL <http://www.immib.org.tr/Eng/demir/stat/urun.html>; Istanbul Mineral Exporters' Association, [undated], Ürün Grubu İtibariyle İstatistik Verileri Türkiye Geneli (Yıllık), accessed January 28, 2000, at URL <http://www.immib.org.tr/maden/stat/urun.html>).

In 1998, the United States was the major individual market, in terms of value, for Turkish metals. Imports were valued at about \$314 million, down from \$325 million in 1997. Regionally, the countries of Central Eurasia and Europe received \$1.2 billion of Turkey's metal exports in 1998 compared with \$1.02 billion in 1997. The countries of Asia and the Pacific accounted for \$197 million of Turkey's metal exports in 1998, significantly down from \$718 million in 1997.

Turkey's mineral imports were dominated by crude oil and refined mineral fuels, valued at \$4.5 billion, as well as a variety of ferrous scrap, metallic ores, steel, and other metals. The Turkish steel industry depended on imported scrap as feed for the country's many electric-arc minimills and the country's unmet demand for flat steel products resulted in Turkish iron

¹Where necessary, values have been converted from Turkish lira to U.S. dollars at the rate of TL261,886=US\$1.00 for 1998, TL152,578=US\$1.00 for 1997, and TL81,699=US\$1.00 for 1996.

and steel imports being valued at \$2.78 billion in 1998 (State Institute of Statistics, March 5, 1999, Provisional foreign trade figures—December 1998, accessed January 28, 2000, at URL <http://www.die.gov.tr/ENGLISH/SONIST/DISTICIST/050399.htm>).

Structure of the Mineral Industry

The mining sector has been estimated to comprise between 750 and 800 mining “establishments,” a term roughly equivalent to “company” or “company division.” These owned and/or operated about 3,000 mines. Most of the mines in the public and private sectors were small by world standards.

Despite the divestment of state-owned minerals sector holdings to domestic and foreign investors, the Government remained a significant factor in most sectors of the Turkish minerals industry through various parastatal (state-owned) industrial corporations and shareholdings in a number of private companies. The privatization process was temporarily postponed at yearend.

State-owned Etibank Madencilik Genel Müdürlüğü was broken up into a number of companies under Eti Holding A.Ş. Subsidiaries of Eti Holding included Eti Alüminyum A.Ş., Eti Bakır A.Ş., Eti Bor A.Ş., Eti Elektromatalurji A.Ş., Eti Gümüş A.Ş., and Eti Krom A.Ş. In May 1998, Sivas Demir Çelik İşletmeleri A.Ş., a steel company, was sold to private investors.

Hard coal was mined by Türkiye Taşkömürü Kurumu Genel Müdürlüğü, and much of the lignite output was produced by Türkiye Kömür İşletmeleri Kumumu. About 78% of Turkey’s total output of crude petroleum and all its natural gas were produced by Türkiye Petrolleri Anonim Ortaklığı (TPAO) and its subsidiaries. Türkiye Petrol Rafinerileri A.Ş. was by far the largest oil refiner in the country. Boru Hatları ile Petrol Taşıma A.Ş. (Botas), the petroleum pipeline company, controlled virtually all the pipeline transport of mineral fuels. In 1998, however the Ministry of Energy and Natural Resources initiated the restructuring of Botas into an import company, a transmission firm, and a distribution enterprise.

Maden Tetkik ve Arama Genel Müdürlüğü was the state agency responsible for geologic exploration, mapping, and research in Turkey.

Commodity Review

Metals

Aluminum.—In June, dissatisfied with the bids, the Government canceled the second tender for the expansion to 100,000 metric tons per year of Eti Holding’s Seydisehir aluminum smelter. The original request for bids for the 4-year smelter modernization and upgrade program had been canceled by Etibank in September 1997 for similar reasons (Metal Bulletin, 1997, 1998b, c; Reuters Ltd., June 10, 1998, Turkey cancels aluminium smelter upgrade tender, accessed June 15, 1998, at URL http://biz.yahoo.com/finance/980610/turkey_sme_1.html).

Copper.—Operations ground to a halt at the Çayeli copper mine in mid-October when employees went out on strike. Production resumed in early December. Despite the 2-month

lapse, 708,000 metric tons (t) of ore were milled, from which 27,200 t of copper and 32,300 t of zinc was recovered (Canada NewsWire Portfolio, February 15, 1999, Inmet Mining announces fourth quarter results, sent February 15, 1999, from e-mail portfolio@newswire.ca).

Gold.—Eurogold Madencilik Ticaret ve Ltd. A.Ş., a joint venture of Mine Or S.A. (66.6%) and Inmet Mining Corp. of Canada (33.3%), continued to have legal problems at the Ovacık prospect near Bergama. A Turkish court affirmed the ruling that the proposed use of sodium cyanide for heap-leaching at Ovacık posed a public health risk (Reuters, November 30, 1998, Turkish court upholds verdict on cyanide leaching, accessed December 4, 1998, at URL <http://biz.yahoo.com/rf/981130/f6.html>). The ruling was not expected to affect sodium cyanide use at the state-owned 100 Yıl Gümüş Maden İşletmeleri Müessesesi Müdürlüğü (Centennial Silver Mine).

Tüprağ Metal Madencilik San. ve Tic. Sti., a subsidiary of Eldorado Gold Corp. of Canada, completed the prefeasibility study on the Efemçukuru project and began obtaining permits for the project. Tüprağ also drilled the Kisladag gold prospect (Eldorado Gold Corporation, 1999).

In January, Woodco Resources Inc. of Canada completed the acquisition of Anatolia Minerals Development Corp. of the Cayman Islands, renaming the combined companies the Anatolia Minerals Development Ltd. In September, Anatolia Minerals formed a joint venture with Rio Algom Ltd. of Canada to explore for base metals and gold on its nine properties, including the Armutbeli, the Bulancak, the Saimbeyli/Tufanbeyli, and the Yenipazar prospects (Anatolia Minerals Development Limited., 1998, Northern Miner, 1998).

Silver.—Eti Holding’s Centennial Silver Mine proposed to build a new grinding plant at its Kutahya facility. The estimated \$7 million expansion project should increase the operation’s production capacity to 122 t of silver from 105 t (Turkish Daily News, July 9, 1998, Two proposals for the Eti Holding grinding facility, accessed July 10, 1998, at URL http://www.turkishdailynews.com/tdn/free_daily_tdn/latest/dom.htm).

Mineral Fuels

Turkey imported nearly 88% of its crude oil demand. Most of Turkey’s oil exploration and production were in the southeastern region. In 1998, TPAO accounted for about 76% of domestic oil production, with 653 active wells; drilled 42 wells, including 23 exploration wells; and had 2 new field discoveries, the Akgün-1 and the Adıyaman 3-R oil wells. About 20 companies were exploring in Turkey, including the joint venture of Aladdin Middle East Ltd., Ersan Petrol Sanayii A.Ş., EEX Corp. of the United States, and White World Exploration LLC; the joint venture of Alarko Alsım Corp. and Shell Exploration B.V.; Amoco Development Co.; BP Exploration Operating Co.; Chevron International Ltd.; Mobil Oil Corp.; Tur-Kan Petrol Ltd., a subsidiary of Trans-Dominion Energy Corp. of Canada; N.V. Turske Perenco; and Petrol Exploration Mediterranean Inc. The international operators were responsible for an additional 11 wells drilled in Turkey (Turkish Petroleum Corp., 1998 annual report, accessed January 28, 2000, at URL <http://www.tpao.gov.tr/rpte/JOINT.HTM>).

In 1998, Shell Co. of Turkey announced its interest in divesting its 27% equity interest in the Anadolou Tasfiyehanesi A.Ş. (ATAS) refinery at Mersin. ATAS produced about 13% of Turkish refined petroleum products in 1998 (Turkish Petroleum Corp., 1998 annual report, accessed January 28, 2000, at URL <http://www.tpao.gov.tr/rpte/activities.html>).

About 1 million barrels per day of Iraqi oil was exported through Turkey's Ceyhan oil terminal under the United Nations oil-for-food exchange program (Resolution 986). In addition to the crude oil, Iraqi diesel fuel was brought across the border into Turkey at Habur (Jon Hemming, January 12, 1999, Turk diesel trade with Iraq flows on amid tension, accessed January 13, 1999, at URL <http://biz.yahoo.com/rf/990112/8u.html>). In June, the Government increased the duty rate on imported Iraqi diesel to 80% from 60% and, in July, formed Silopi A.Ş., which received the exclusive right to sell the imported Iraqi diesel (Middle East Economic Digest, 1998c; Turkish Daily News, July 28, 1998, Silopi A.S. established for Habur diesel trade, accessed July 29, 1998, at URL http://www.turkishdailynews.com/free_daily_tdn/latest/dom2.htm).

Reserves

Turkey's mineral inventory is diverse and large, but many of the deposits, especially for metallic minerals, are small (Erseçen, 1989). Resources of metallic commodities minable by large-scale methods are known for bauxite, chromite, copper and copper-zinc, gold, iron, and silver. Turkey is better known for its deposits of industrial minerals, most significant of which are barite, boron, clays, limestone and marble, magnesite, perlite, pumice, strontium, and trona. The country has large lignite reserves. The crude oil reserves were hosted in a large number of small fields.

Infrastructure

Turkey's extensive road and railroad infrastructure was heavily used for the transport of mineral commodities. A 124-kilometer (km) railway was proposed to link Kars, Turkey, with Tbilisi, Georgia. Turkey had 2,092 km of crude petroleum and 2,321 km of refined petroleum products pipelines. The longest stretch of pipeline was the 641-km twin line connecting Iraq with the Ceyhan oil-loading facility at Yumurtalık in southeastern Turkey. Ceyhan was also the terminus for a 447-km pipeline to the refinery in Karakale. There were no reports of significant damage to the Ceyhan petroleum facilities by the 6.2 magnitude earthquake in June 1998.

The oil port at Dörtöyl, 28 km north of Iskenderun, was the terminus of a 494-km pipeline from the oil refinery at Batman, with shorter spurs from this line to the oilfields near Batman (Şelmo) and around Adıyaman. Turkey had about 900 km of natural gas pipeline, which was used to import natural gas from Russia. A 303-km natural gas pipeline linking the Iranian natural gas system to Erzurum, Turkey, was under construction. In 1998, the 1,003-km extension of the Erzurum line to Ankara was begun. In western Turkey, Botas proposed to build a 215-

km natural gas pipeline extension from Karacabey south to Izmir and to extend the pipeline west to Çanakkale.

In 1998, Amoco Corp. and affiliates of GE Capital Structured Finance Group and Bechtel Enterprises Inc. of the United States formed the TransCaspian Gas Pipeline System, which proposed to construct a 1,200-km natural gas pipeline from Turkmenistan to Turkey. The various proposed Turkmenistan gas pipeline routes through Azerbaijan and Georgia and through Iran were subject to economic constraints and political negotiations (Journal of Commerce, 1998; Lelyveld, 1998; Middle East Economic Digest, 1998a; Middle East Economic Digest, 1998b; PRNewswire, June 29, 1998, Consortium formed to develop and operate new TransCaspian gas pipeline will transport natural gas from Turkmenistan to Turkey, accessed June 30, 1998, at URL <http://www.newspage.com/cgi-bin/pnp.GetStory?story=p0629104.500&topic=726&date=19980630>; Turkish Daily News, August 17, 1998, Natural gas in the 21st century, accessed August 18, 1998, at URL http://www.turkishdailynews.com/free_daily_tdn/latest/dom.htm; Turkishpress.com, October 30, 1998, Turkmen natural gas agreement signed. . . , accessed November 2, 1998, at URL <http://www.turkishpress.com/aa/index.html>; Kiyoshi Takenaka, February 27, 1998, Focus—Oil pipeline to run to Turkey - Azerbaijan, accessed March 2, 1998, at URL http://biz.yahoo.com/finance/980227/oil_pipeli_1.html).

The Government was negotiating to purchase 16 billion cubic meters per year of natural gas from Turkmenistan (Turkish Press, October 20, 1998, Turkey and Turkmenistan to initial a natural gas agreement on Tuesday in Ashkhabad, accessed October 20, 1998, at URL <http://www.turkishpress.com/aa/index.html>). The Government also approved the 1,200-km "Blue Stream" pipeline to transport additional Russian natural gas under the Black Sea from Izobilnoye, Russia, to landfall at Samsun, Turkey.

Turkey had many ports capable of handling mineral-commodity shipments. Major coal-importing ports included Ereğli and Iskenderun. Chromite was shipped from various Anatolian ports on the Marmara coast, as well as from Antalya and Iskenderun, which handled all Turkey's ferrochrome exports. Steel, steel scrap, and iron ore imports also were handled at many ports, particularly Aliaga, Ereğli, Iskenderun, and Mersin, and at various sites in the Istanbul-Izmit area. Turkey's boron minerals and chemicals were exported from Bandırma. Copper concentrates, ore, and blister were shipped from Samsun, and copper concentrates, from Hopa, Rize, and Iskenderun. Marine terminals at Ambarlı were used to ship cement. To reduce its shipping costs, Karabük Demir ve Çelik A.Ş. (Kardemir) proposed to build a \$150 million port at Filyos, near Zonguldak, on the Black Sea (Metal Bulletin, 1998a). Kardemir had been using the port at Iskenderun, about 1,000-km south of the steel plant, to import raw materials and export products.

Because of electrical power demand has been growing at an estimated 8% to 10% per year, Turkey was in the process of greatly expanding its electrical generating capacity. In 1998, electrical generating capacity was 22,000 megawatts (Dünya

Online, Energy sector in Turkey, accessed February 24, 1999, at URL <http://www.dunya.com/energy/enrap.html>). Additional capacity would be generated by hydroelectric and coal-, natural gas-, and nuclear-fueled powerplants.

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Major Sources of Information

General Directorate of Mines

(Maden Genel Müdürlüğü)

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TABLE 1
TURKEY: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997	1998 e/
METALS					
Aluminum:					
Bauxite 2/	445,020	232,278	544,513	369,482 r/	458,028 3/
Alumina:					
Gross weight	155,299	171,978	159,298	164,333	156,825 3/
Metal, smelter	59,750	61,514	60,000 e/	62,019	60,000
Antimony:					
Ore, mine output:					
Gross weight	1,415	7,856	5,384	585 r/	500
Sb content	75	416	285	31 r/	30
Concentrates:					
Gross weight	90 e/	1,163	700	500 e/	100
Sb content	55 e/	291	175	125 e/	20
Cadmium	22	23 e/	42	89 r/	69 3/
Chromite:					
Gross weight (34% to 43% chromic oxide)	1,270,431	2,080,043	1,279,032 r/	1,702,623 r/	1,404,470 3/
Salable product e/	501,851 3/	1,460,000	900,000 r/ e/	1,300,000	1,000,000
Copper:					
Mine output (exclusive of pyrite): 4/					
Gross weight	3,346,490	3,185,628	3,518,754	3,797,874 r/	4,052,175 3/
Cu content of ore	34,902	40,085	33,792	36,460 r/	40,000
Concentrates (exclusive of pyrite):					
Gross weight	139,919	141,000 e/	133,350	142,928 r/	160,000
Cu content	28,891	24,000 e/	29,580	31,923 r/	32,000
Metal:					
Smelter output (primary + secondary)	30,400	33,700 e/	38,600 e/	32,491	35,000
Refined e/	82,700	98,500	120,000	120,000	120,000
Gold, byproduct of base metals refining e/ 5/ kilograms	996	1,200	1,000	1,000	1,000
Iron and steel:					
Iron ore:					
Gross weight thousand metric tons	5,755	4,931	6,404	5,986 r/	5,885 3/
Fe content e/ do.	3,148	2,750	3,500	3,239 r/ 3/	3,200
Metal:					
Pig iron and ferroalloys:					
Ferrochromium	97,585	94,251	101,450	108,320 r/	110,175 3/
Ferrosilicon	4,930	4,900	4,460	4,730 r/	4,810 3/
Pig iron	394,168 r/	330,070 r/	489,516 r/	577,427 r/	456,465
Steel, crude including castings thousand metric tons	12,074	12,744	13,382	13,644	13,351 3/
Lead:					
Mine output, Pb and Pb-Zn ores:					
Gross weight	232,140	253,100	234,541	262,260 r/	292,065 3/
Pb content	11,158	10,376	10,971	13,113 r/	13,500
Concentrates:					
Gross weight	5,683	5,318	4,494	12,063 r/	12,100
Pb content	1,279	1,196	3,140	7,912 r/	7,900
Metal, refined e/	5,100	4,000	4,000	7,000	7,000
Manganese ore, gross weight 6/	34,500	37,000 r/	37,000 e/	31,160 r/	53,283 3/
Silver, mine output, Ag content e/ 7/ kilograms	65,000	70,000	70,000	90,200	110,000
Zinc:					
Mine output, Zn and Pb-Zn ore:					
Gross weight	297,252	73,110	104,819	79,035 r/	45,795 3/
Zn content	26,300 e/	9,118	14,921	11,255 r/	6,000
Concentrates:					
Gross weight	30,000 e/	9,760 e/	9,981	7,525 r/	5,000
Zn content	10,000 e/	5,774	5,529	4,169 r/	3,000
Metal, smelter, primary	18,567	17,050	22,392	37,074 r/	35,716 3/
INDUSTRIAL MINERALS					
Aluminum sulfate (alunite)	12,165	9,763	6,625	8,323 r/	10,624 3/
Barite, run of mine	116,220	153,719	104,872	226,594 r/	160,042 3/
Boron minerals:					
Run of mine	2,092,032	1,768,919	2,400,635	2,602,386 r/	2,754,082 3/
Concentrates	1,139,980	1,143,994	1,446,697	1,568,571 r/	1,650,000

See footnotes at end of table.

TABLE 1--Continued
TURKEY: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997	1998 e/
INDUSTRIAL MINERALS--Continued					
Cement, hydraulic thousand metric tons	29,493	33,153	35,214	36,035 r/	38,200 3/
Clays:					
Bentonite	516,187	602,499	515,452	521,158 r/	565,708 3/
Kaolin	179,775	489,635	449,561	472,646 r/	403,733 3/
Other	956,012	1,649,192	6,405,377	6,400,000 e/	6,000,000
Emery	12,000	14,149	11,092	12,345 r/	19,027 3/
Feldspar, run of mine	502,608	760,250	910,814	1,011,542 r/	1,089,483 3/
Fluorspar	6,671	8,873	4,828	5,000 e/	5,000
Glass, crude e/ thousand metric tons	1,300	1,150	1,133 3/	1,369 3/	1,400
Graphite, run of mine e/	20,000	20,000	20,000	15,000	15,000
Gypsum, other than that for cement	596,962	596,967	754,277	413,802 r/	351,557 3/
Lime 8/ thousand metric tons	1,800 e/	897	1,023	1,170 r/	1,066 3/
Magnesite, run of mine	1,279,614	1,928,064	2,339,138	1,409,768	2,703,343 3/
Meerschaut kilograms	2,350	1,000	500	400	-- 3/
Nitrogen, N content of ammonia e/	350,000	366,000 3/	518,800	558,000	560,000
Perlite, run of mine	164,582	171,058	157,580	103,416 r/	124,312 3/
Pumice 9/	947,174	845,000 r/	774,000	681,000 r/	579,000
Pyrites, cupreous, gross weight	50,000 e/	307,992	538,140	559,500 r/	699,408 3/
Silica sand, gross weight 10/ thousand metric tons	741	755	779	900 r/	1,107 3/
Sodium compounds:					
Salt, NaCl, all types do.	1,353	1,444	2,068	2,344 r/	2,170 3/
Soda ash (trona) e/ do.	385	385	400	500 3/	500
Sodium sulfate, concentrates	307,049	314,192	328,953	300,000 e/	300,000
Stone:					
Dolomite	378,004	425,877	981,683	689,989 r/	829,775 3/
Limestone, other than for cement thousand metric tons	11,000 e/	20,496	40,456	49,108 r/	52,355 3/
Marble e/ do.	750	272	1,287	1,166 r/	1,704 3/
Quartzite	1,350,299	1,364,558	2,807,279	1,878,339 r/	2,301,270 3/
Strontium minerals, celestite: e/					
Run of mine	45,000	50,000	50,000	50,000	50,000
Concentrates	25,000	30,000	30,000	30,000	30,000
Sulfur: e/					
Native, other than Frasch	16,673 3/	17,000	--	--	--
S content of pyrites	27,000	163,000	255,000	250,000 r/	350,000
Byproduct:					
Petroleum	25,000	26,000	25,000	20,000	15,000
Other	5,000	20,000	25,000	20,000	20,000
Total	73,673	226,000	305,000	290,000	385,000
Talc e/	4,000	4,000	4,000	4,000	5,000
MINERAL FUELS AND RELATED MATERIALS					
Asphalt, natural	108,364	219,848	126,751	117,310 r/	157,334 3/
Carbon black	35,000 e/	39,975	39,273	39,061 r/	39,971 3/
Coal:					
Hard coal, run of mine thousand metric tons	4,211	3,377	3,582	3,646 r/	3,336 3/
Lignite, run of mine do.	55,038	56,031	57,532	56,780 r/	66,499 3/
Coke and semicoke do.	2,799	3,021	2,297	2,335 r/	2,144 3/
Gas:					
Natural, marketed thousand cubic meters	198,630	181,515	203,967	250,804	561,995 3/
Coal, manufactured e/ do.	35,000	35,000	37,000	35,000	15,000
Petroleum:					
Crude thousand 42-gallon barrels	26,399	24,124	25,015	24,696 r/	23,072 3/
Refinery products:					
Liquefied petroleum gas do.	8,503	9,185	9,580	8,418 r/	8,774 3/
Gasoline do.	29,521	31,746	30,950	55,248 r/	59,043 3/
Naphtha do.	10,761	12,110	13,227	13,644 r/	15,917 3/
Jet fuel do.	10,380	12,119	11,324	13,445 r/	13,767 3/
Kerosene do.	819	605	726	578 r/	583 3/
Distillate fuel oil 11/ do.	55,197	59,556	55,838	40,987 r/	38,532 3/
Lubricants e/ do.	2,000	2,000	2,000	4,177 r/ 3/	4,714 3/
Residual fuel oil do.	50,640	52,043	49,459	10,148 r/	8,973 3/
Asphalt do.	5,389	5,940	7,233	8,029	10,912 3/
Unspecified e/ 12/ do.	6,700	6,700	4,000	33 r/ 3/	26 3/
Total do.	179,910	192,004	184,337	154,707 r/	161,241 3/

See footnotes at end of table.

TABLE 1--Continued
TURKEY: PRODUCTION OF MINERAL COMMODITIES 1/

e/ Estimated. r/ Revised.

1/ Table includes data available through January 24, 2000. Large quantities of construction materials (clay, sand, and gravel) are quarried. Also quarried are basalt, diabase, granite, onyx, sandstone, serpentine, slate, and travertine for building stone and limestone and gypsum for cement manufacture; information is, however, inadequate to make estimates of output levels.

2/ Data are for public sector only. Data for private sector production are not available, but production is believed to be approximately 30,000 metric tons per year.

3/ Reported figure.

4/ Copper mines produce a copper concentrate (of about 22% Cu) and a cupreous pyrite concentrate (about 0.7% Cu). Copper is not recovered from the cupreous pyrite concentrate.

5/ Data are estimated content of Turkish copper refinery tankhouse slimes.

6 Does not include manganiferous iron ore from the Deveci Mine, production of which amounts to several hundred thousand metric tons per year and has a manganese content of 3% to 5%.

7/ Includes estimated content of base metals refinery tankhouse slimes.

8/ Data are lime produced for steel production and do not include the widespread artisanal production of lime for whitewash and sanitation purposes.

9/ Turkish pumice production is officially reported in cubic meters and has a density reported to range from 0.5 to 1.0 metric ton per cubic meter. Values in this table have been converted by using 1 cubic meter=0.75 ton.

10/ Previously reported as estimated production of washed silica sand, in tons: 1994--415,000; 1995--310,000; and 1996--385,000.

11/ Diesel fuel and special heating oil.

12/ Includes refinery fuel and losses.

THE MINERAL INDUSTRY OF THE UNITED ARAB EMIRATES

By Bernadette Michalski¹

The downturn in international petroleum prices during 1998 adversely affected the United Arab Emirates² (UAE) because revenues associated with the production of crude petroleum and natural gas accounted for a significant proportion of the national economy. Abu Dhabi dominated the UAE's hydrocarbon industry, accounting for nearly 90% of the country's crude oil production and 70% of natural gas production (Arab Petroleum Research Center, 1999, p. 464). Other minerals and mineral commodities produced in the UAE included aluminum and steel from Dubai, ammonia from Abu Dhabi, cement manufactured in six emirates, and chromite from Fujairah. (See table 1.) All mineral resources were controlled by the individual emirates and only loosely administered by the Federal Government. International petroleum companies were heavily involved in

crude oil and natural gas development and infrastructure projects in Abu Dhabi.

The UAE had reported petroleum reserves of 97.8 billion barrels and natural gas reserves of 5.8 trillion cubic meters. Most of the UAE's hydrocarbon reserves were in Abu Dhabi, the location of 94% of petroleum reserves and 92% of natural gas reserves (Arab Petroleum Research Center, 1999).

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Arab Petroleum Research Center, 1999, United Arab Emirates, in Arab oil & gas directory: Arab Petroleum Research Center, 640 p.

Major Source of Information

Ministry of Petroleum and Mineral Resources
P.O. Box 59, Abu Dhabi, United Arab Emirates
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¹Deceased.

²Comprises the following seven Emirates: Abu Dhabi, Ajman, Dubai, Fujairah, Ras Al-Khaimah, Sharjah, and Umm al-Qaywayn.

TABLE 1
UNITED ARAB EMIRATES: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity 2/	1994	1995	1996	1997	1998 e/
Aluminum, primary	246,200 r/	247,400 r/	258,500 r/	381,000 r/	352,000
Cement, hydraulic e/ thousand tons	5,000	5,918 3/	6,000	6,000	6,000
Chromite, gross weight	55,000	37,000	56,000	61,000	60,000
Fertilizer materials:					
Ammonia:					
Gross weight e/	347,500	441,000	405,000	453,121 r/	404,000
N content	286,500	362,700	331,200	372,500	331,300
Urea:					
Gross weight e/	450,000	575,000	490,000	651,331 r/	650,000
N content	230,000	293,600	258,400	303,520 r/	302,900
Gas, natural:					
Gross million cubic meters	34,360	40,860	46,530	48,500	49,000
Dry do.	25,820	31,320	36,250	37,300	37,000
Gypsum e/ thousand tons	95	90	90	90	90
Lime e/ do.	45	50	50	50	50
Natural gas plant liquids e/ thousand 42-gallon barrels	80,000	100,000	110,000	110,000	110,000
Petroleum:					
Crude do.	792,000	800,500	831,470	845,340	880,000
Refinery products:					
Gasoline do.	11,970	12,738	12,446	12,812 r/	12,800
Kerosene do.	10,110	21,243	20,330	24,419 r/	24,000
Distillate fuels do.	21,681	24,345	24,090	27,521 r/	27,000
Residual fuels do.	21,863	12,995	16,717	17,812 r/	17,500
Other do.	10,475	12,665	12,154	26,061 r/	26,000
Total do.	76,099	83,986	85,737	108,625 r/	107,300
Steel e/	70,000	70,000	70,000	70,000	70,000
Sulfur, byproduct: e/					
From petroleum refining	24,500	26,000	26,000	27,000 r/	27,000
From natural gas processing	225,500	230,500	233,000	210,000	210,000
Total	250,000	256,500	259,000	237,000 r/	237,000

e/ Estimated. r/ Revised.

1/ Table includes data available through March 17, 2000.

2/ In addition to the commodities listed, crude industrial minerals, such as common clays, diabase, gravel, limestone, marble, sand and shale, presumably are produced, but output is not reported, and general information is inadequate to make reliable estimates of output levels.

3/ Reported figure.

THE MINERAL INDUSTRY OF THE REPUBLIC OF YEMEN

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Crude oil production and natural gas liquids recovered from associated natural gas were Yemen's principal mineral industries. Natural gas as liquified natural gas (LNG), however, was expected to play a greater role in the near future. Other mineral output includes cement, dimension stone, gypsum, and salt. (See table 1.) Increased petroleum output in 1998 was attributed to the Jannah Field and the Shabwa East Field coming on-stream.

In 1998, total imports dropped by more than \$200 million to \$2.2 billion, and exports dropped by more than \$750 million to \$1.5 billion mainly because of lower oil prices (Middle East Economic Digest, 1999a).

According to the Ministry of Oil and Mineral Resources, exploration for gold was being conducted by American, Canadian, and Indonesian companies in eastern and western Yemen in the areas of Dhamar, the Hadramout, and Hajja (Mining Journal, 1998). Among these, Cantex Mine Development Ltd. of Canada identified a number of base metal and precious-metal occurrences in northwestern Yemen. The company held a prospecting permit for a 41,500-square-kilometer (km²) area (Mining Journal, 1999).

Cement output from Yemen's three existing cement plants totaled about 1.2 million metric tons (Mt) in 1998, less than one-half of the nation's consumption requirements of 2.8 Mt. To ease import requirements (1.6 Mt in 1998), the Government issued two new licenses for the construction of the country's first two private cement factories.

Yemen LNG Co. Ltd. was developing gas reserves in the Marib al-Jawf Fields for the production of LNG. Partners in the project were the Total Group of France at 36%; Yemen Gas Co., 26%; Hunt Oil Co. of the United States, 15.11%; Exxon Corp. of the United States, 14.51%; and SK Corp. of the Republic of Korea, 8.38%. Yemen LNG planned to build a two-train plant with capacity to export 5.3 million metric tons per year of LNG at Balhaf on the Gulf of Aden. The port of Pipavav in Gujarat State, India, will be the destination. Plant construction startup has been put back to January 2001 from January 1999 with exports due to begin by 2003 (Oil & Gas Journal, 1998).

More than 20 international companies were involved in hydrocarbon exploration in Yemen in 1998. Most active among these was Canadian Occidental Petroleum Ltd. with exploration permits covering more than 8 million hectares, or 80,000 km². In early 1998, the company acquired interest in Blocks 50 and 52 and, later in the year, four large contiguous exploratory blocks (11, 12, 36, and 54) in the northeast. The company also held 52% in the Masila tract (Block 14). In the Masila Block, total output from 13 oilfields rose by 6% to a record 201,000 barrels per day (bbl/d) in 1998, and petroleum reserves were

increased from 156 million barrels (Mbbbl) to 189 Mbbbl (Middle East Economic Digest, 1999b). Canadian Occidental Petroleum signed an exploration agreement with Kerr McGee Yemen Ltd. for exploration in Block 51. Each company held 43.75% interest in Block 51. The remaining interest, 12.5%, was assigned to an affiliate of the Ministry of Oil and Mineral Resources (Kerr McGee Corporation, April 8, 1998, Kerr-McGee announces exploration agreement in Yemen, press release, accessed April 17, 1998, at URL http://biz.Yahoo.com/prnews/980408/ok_kerr_mc_2.html).

In January 1998, the Yemeni Parliament approved the awarding of Block 53 (East Saar) to Dove (United Kingdom) (75%) and Yemen General Corp. for Oil & Gas (25%). TransGlobe Energy Corp. announced that the Parliament of Yemen ratified the Block S-1 production-sharing agreement in June 1998. The company will have 150 km² of three-dimensional seismic data acquired and interpreted and drill three wells at an approximate total cost of \$11 million. Block S-1, which covers an area of 4,484 km², is near existing pipelines and adjacent to the Marib al Jawf production area. In addition to Block S-1, the company held a 9.8% interest in Block 32 (TransGlobe Energy Corp, June 15, 1998, Transglobe announces ratification of production sharing agreement for Block S-1, Republic of Yemen, press release, accessed June 15, 1998, at URL http://biz.yahoo.com/bw/980615/trans_globe_2.html).

The Yemen General Corp. for Oil & Gas signed a \$25 million production-sharing agreement with Petrocorp of the United States covering Block 15 in the Hadramout province (OPEC Bulletin, 1998). In April, the Ministry of Oil & Mineral Resources signed a memorandum of understanding with Bula Resources (Holdings) PLC of Ireland for exploration in Block 6 in the Shabwa Governorate and Block 35 in the Hadramout. By August, Bula Resources abandoned the project reportedly because analysis undertaken since April indicated that the blocks would not satisfy the company's required investment criteria (Middle East Economic Digest, 1998c).

In March, a production-sharing agreement was approved for Preussag Energie GmbH of Germany for Block S-2, known as Al Ouqlah in Shabwa (Middle East Economic Digest, 1998b).

Petroleum production from the Marib al Jawf Fields was expected to decline. Two new fields, however, came on-stream in late 1997; this should more than offset reduced production from the Marib al Jawf Fields. The Yemen General Corp. for Oil & Gas reported a production rise to 75,000 bbl/d from 25,000 bbl/d at the Jannah Field and to 30,000 bbl/d from 20,000 bbl/d at Shabwa East. Another promising discovery was reported in January 1998 by Clyde Petroleum of the United

¹Deceased.

Kingdom when the company announced that it had struck oil at the Tasour-1 well in Block 32 about 10 kilometers north of the Masila Field. An appraisal program was planned.

In 1998, total crude oil production averaged nearly 380,000 bbl/d, the bulk of which was derived from two areas—the Masila Field at 201,000 bbl/d and the Marib al Jawf Fields at 140,000 bbl/d. Remaining production was derived from the Jannah and the Shabwa East Fields. Crude-oil-production capacity was expected to rise to 420,000 bbl/d in 1999.

Yemen had two state-owned refining facilities—the 100,000-bbl/d-capacity Aden refinery and a 10,000-bbl/d topping plant. In May 1998, the Council of Ministers approved the sale of 50% of Aden Refinery Co. to private investors. The proceeds from the sale will be used to finance the upgrade of the Aden refinery. In 1998, the refinery produced about 100,000 bbl/d—70,000 bbl/d for local consumption and 30,000 bbl/d for Malaysia's Petrolia Nasional Bhd. (Petronas) (Middle East Economic Digest, 1998a).

Yemen's proven oil reserves were estimated to be 4 billion barrels in 1998. The known reserves are concentrated in the Marib al Jawf area in the north, the East Shabwa and the Masila areas in the south, and the Jannah and the Iyad areas in central Yemen. Natural gas reserves are at 480 million cubic meters (Arab Oil & Gas Directory, 1998, p. 533).

The economic success of the Republic of Yemen is dependent upon fulfillment of its planned development and its ability to avoid serious political unrest. The 150,000-bbl/d-capacity Marib oil export pipeline was damaged in an explosion set off by tribesmen on September 20, 1998. Although unrest within the recently united regions of the country continues, political

unrest with neighboring Eritrea was eased when an international arbitration panel ruled in favor of Yemen in its dispute with Eritrea over three Red Sea islands—Greater Hanish, Lesser Hanish, and Zuqar.

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Major Publication

Republic of Yemen
 Ministry of Planning and Development
 Central Statistical Organization
 Statistical Year-Book 1998

TABLE 1
 REPUBLIC OF YEMEN: PRODUCTION OF MINERAL COMMODITIES 1/

Commodity	1994	1995	1996	1997	1998
Cement thousand metric tons	500	1,088	1,028 r/	1,235 r/	1,207
Gypsum do.	95 r/	96 r/	97 r/	101 r/	102
Marble thousand square meters	80	80	82	84	86
Natural gas: e/					
Gross million cubic meters	100,000	100,000	100,000	100,000	100,000
Liquids thousand 42-gallon barrels	2,600	2,600	2,600	2,600	2,600
Petroleum:					
Crude do.	122,275	125,925 r/	126,655 r/	125,560 r/	138,600
Refinery products:					
Gasoline do.	8,000 e/	9,000 r/ e/	8,913 r/	8,803 r/	8,803
Kerosene do.	2,500 e/	2,500 r/ e/	4,935 r/	4,073 r/	4,073
Distillate fuel oil do.	10,500 e/	10,500 r/ e/	10,525 r/	10,530 r/	10,533
Residual fuel oil e/ do.	10,300 r/ e/	10,300 r/ e/	10,300 r/	10,300 r/	10,303
Other e/ do.	1,000	2,000	2,000	2,000	2,000
Total do.	32,300 r/ e/	34,300 r/ e/	36,673 r/	35,706 r/	35,712
Salt metric tons	110,000 e/	125,000 r/	135,000 r/	146,000 r/	147,000
Stone, dimension thousand metric tons	2,377	2,385	2,397	2,485	2,497

e/ Estimated. r/ Revised.

1/ Table includes data available through July 30, 1999.

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